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# ***JPRS Report***

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# **Science & Technology**

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***China***

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## SCIENCE &amp; TECHNOLOGY

## CHINA

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## PN SEQUENCES FOR SPREAD-SPECTRUM COMMUNICATION, NEW CLASS OF CDMA CODES

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[Article by Wang Ke [3769 0668] of the National Research Center of Science and Technology for Development, Beijing, and Yin Xiaowei [1438 1420 4250] of the Institute of Spacecraft System Design, Beijing. Received Jan 86, revised Jan 87]

[Text] Abstract: The characteristics of PN sequences are discussed based on the results obtained in recent years. A conjecture that the binary sequences which reach the Baumert-Wang-Welch's lower bounds are the complete set of binary PN sequences is proposed. Further, an approach for generating the non-linear M-sequences through some specific transformations over GF(p) is given. Finally, some primitive results about the Gold-like sequences over GF(p) are presented and these sequences may be applied to the p-ary channels as a new class of CDMA codes.

## I. Discussion of Pseudo Random Properties

The so-called PN sequence refers to a periodic binary sequence which satisfies the following "pseudo random" properties:

(1) There are an equal number of "0" elements and "1" elements in the sequence; i.e.,  $p(1) = p(0) = 1/2$ , where  $p(x)$  is the probability of appearance of the element  $x$  in the sequence. (2) Within a single period of the sequence, the number of runs with length 1 is equal to 1/2 of the total number of runs, the number of runs with length 2 is 1/4 of the total, the number of runs with length 3 is 1/8 of the total, etc., i.e.,  $p(k) = \frac{1}{2}p(k-1)$  where  $k$  is the length of the run. (3) It has a two-valued autocorrelation function; the autocorrelation function is defined as:

$$a_\tau = \sum_{t=0}^{L-1} x_t \cdot x_{t+\tau} \quad (1)$$

where  $L$  is the period,  $x_t \in \{1, -1\}$ . For the PN sequence we have:

$$\begin{cases} a_\tau = L, & \text{for } \tau = 0, L, 2L, \dots \\ a_\tau = -1, & \text{for other values of } \tau \end{cases}$$

It will be shown in the following examples that the above pseudo random properties are not universally applicable; they require modification in certain cases.

Example 1: A binary sequence with  $L = 15$

$$\{x_i\} = (1\ 0\ 0\ 0\ 1\ 1\ 1\ 1\ 0\ 1\ 0\ 1\ 1\ 0\ 0)$$

The reader can verify for himself that this sequence does not satisfy the first two properties exactly; only the third property is satisfied.

Example 2: A binary sequence with  $L = 16$

$$\{x_i\} = (1\ 1\ 1\ 0\ 1\ 0\ 1\ 1\ 0\ 1\ 1\ 0\ 0\ 0\ 0\ 0)$$

Examination of this sequence shows that it satisfies both properties (1) and (2), but with regard to (3), the autocorrelation function is not two-valued, but multi-varied. However, the maximum value of the non-in-phase autocorrelation functions (i.e.,  $r \neq 0, L, 2L, \dots$ ) does not exceed zero, which is quite adequate for most practical applications.

Example 3: A binary sequence with  $L = 18$

$$\{x_i\} = (1\ 1\ 1\ 1\ 0\ 1\ 0\ 0\ 1\ 0\ 0\ 0\ 1\ 1\ 0\ 0\ 0\ 1)$$

Examination of this sequence shows that property (1) is exactly satisfied, property (2) is not completely satisfied, and property (3) is not satisfied. However, the maximum value of the non-in-phase autocorrelation functions is less than 2, which is acceptable in practical applications.

The above three examples represent three different types of binary sequences (the lengths of the periods are respectively  $L = 4t-1$ ,  $L = 4t$  and  $L = 4t+2$ , where  $t$  is a positive integer) where infinite set exists.<sup>[1,2]</sup> The maximum value of their non-in-phase autocorrelation functions depends only on the type of period length; it is independent of the actual length of the period. Therefore, the ratio between this value and the peak value of the in-phase autocorrelation functions tends to zero as the period length  $L$  approaches infinity. The first two pseudo random properties are approximately satisfied by all three sequences in a probabilistic sense as  $L$  increases. Therefore, the so-called pseudo random sequences are not limited to the familiar maximum-length linear shift register sequences (simply called  $m$  sequences); they are much more general. In order to improve the general applicability of pseudo random properties, it is suggested that property (3) be modified as follows: the ratio between the maximum value of non-in-phase autocorrelation function and the peak value of the in-phase autocorrelation function approaches zero as the period increases to infinity, i.e.,

$$\lim_{L \rightarrow \infty} \max_{r \neq 0, L, 2L, \dots} a_r / L = 0 \quad (2)$$

Study shows (without rigorous mathematical proof) that equation (2) is a sufficient and necessary condition for classifying binary pseudo random sequences, i.e., if a sequence satisfies condition (2), then the first two

properties are also satisfied (probabilistic approximation). Therefore, the most studied and best understood topic of pseudo random sequences is the periodic autocorrelation property, and the core of the study deals with the bounds of the autocorrelation function.

Equation (2) implies that the periodic autocorrelation function of the PN sequence is bounded. The lower bound of the autocorrelation function was first derived by Baumert.<sup>[1]</sup> Let  $A_{\max} = \max_{i \neq 0} a_i$ , then the Baumert bound is:

$$\begin{aligned} A_{\max} &\geq -L/L-1, & \text{when } L \text{ is even} \\ &\geq -1 & \text{when } L \text{ is odd} \end{aligned} \quad (3)$$

The expression (3) is exact only when  $L \equiv 3$  or  $(-1) \bmod 4$ , as in Example 1; but it is inexact for the conditions of Example 2 and Example 3. The exact lower bound of the periodic autocorrelation function of any period length was suggested by Wang Ke and Welch,<sup>[2]</sup> which is as follows:

$$\begin{aligned} \text{If } L &\equiv 0 \bmod 4, & \text{then } A_{\max} &\geq 0 \\ L &\equiv 1 \bmod 4, & A_{\max} &\geq 1 \\ L &\equiv 2 \bmod 4, & A_{\max} &\geq 2 \\ L &\equiv 3 \text{ (or } -1) \bmod 4, & A_{\max} &\geq -1 \end{aligned} \quad (4)$$

For convenience, the lower bound given by (4) is referred to as the Baumert-Wang-Welch bound. This bound indicates that one cannot find a sequence whose non-in-phase periodic autocorrelation function (maximum value) is less than the value given by (4). For example, in the case of  $L \equiv 2 \bmod 4$ , a sequence whose autocorrelation function is less than 2 does not exist. For this reason, (4) is the most important result of binary pseudo random sequences. If an arbitrary sequence has a maximum autocorrelation function equal to the lower bound given by (4), then it is a PN sequence, otherwise it is not. This simple test is very convenient to use in practice. However, the following assertion still requires rigorous mathematical proof: Binary sequences which reach the Baumert-Wang-Welch lower bound constitute the complete set of PN sequences.

In the following section, a number of known PN sequences which reach this lower bound are introduced.

## 11. PN Sequences Which Reach the Baumert-Wang-Welch Bound

### Case 1. $L \equiv 0 \bmod 4, A_{\max} = 0$

All binary sequences with non-positive autocorrelation functions given in Ref. [2] belong to this category. The existence of this type of sequence is infinite, particularly the "positive-negative" sequences with singular autocorrelation properties. The structure of this type of sequence was independently discovered by Alltop<sup>[3]</sup> and by Wang, Welch,<sup>[2]</sup> In section 4 we shall describe the method of generating this type of sequence. It should be pointed out that this is not a linear shift register sequence, but rather it



is a non-linear binary sequence with even length (multiples of 4); it can be easily matched with computer bytes, and therefore is suitable for secure spread spectrum or data-encryption applications.

Case 2.  $L \equiv 1 \pmod{4}$ ,  $A_{\max} = 1$

The known sequences which reach this bound include the Beck [phonetic] sequence with  $L = 5, 13$ . Based on the fact that there exist infinite sets for three other autocorrelation bounds, it is conjectured that the same conclusion applies in the present case. However, the general algebraic structure of these sequences has not yet been found.

Case 3.  $L \equiv 2 \pmod{4}$ ,  $A_{\max} = 2$

This type of sequence is a non-linear sequence which can be obtained by applying square residual transformation to the generalized m-sequence discussed below. To the authors' knowledge, this type of sequence has not been discussed in the literature. A few examples of this sequence are given below (expressed in octal numbers, 001+1):

$L=30$  7714112344;  $L=22$  7436010;  $L=18$  731061.

Case 4.  $L \equiv 3 \pmod{4}$  (or  $-1 \pmod{4}$ ),  $A_{\max} = -1$

The sequences which reach this bound include the m-sequence, the residual square sequence, the Hall sequence and the double prime number sequence.[1] The m-sequence is the best understood and most widely used PN sequence. But since it is generated by linear shift registers, it is easily decoded, and therefore seldom used directly in an all-digital communication system.

### III. CDMA Codes Which Reach the Welch Cross-Correlation Bound

In Ref. [4], optimum CDMA codes are discussed from the point of view of Welch cross-correlation bounds; they include the Kasami, Bent and group character sequences. These sequences will not be discussed in this paper.

In practice, the most commonly used CDMA code is the Gold sequence. Although it does not satisfy the Welch cross-correlation bound, it does have uniform correlation functions. It is generated on the basis of the so-called optimum pairs of m-sequences. The theory and method of generating this type of sequence can be found in numerous papers published in this country and abroad.

### IV. Generalized m-Sequences and Their Derived Sequences

#### 1. Generation of Generalized m-Sequences and Their Properties

The spread spectrum sequence discussed earlier is mostly defined on  $GF(2)$ ; i.e., the elements of the sequence are taken only from a two-element alphabet table. In practice, the alphabet table can be multi-valued, as in multi-phase modulation. Assume that the number of elements in the alphabet table is an odd prime number  $p$ , then there exists a maximum-length linear shift



register sequence on  $GF(p)$ , [5,6] but the register in this case should be in  $p$  state, and the addition and multiplication operations should be carried out with modulo  $p$ , not modulo 2. Since it is customary to call the maximum-length linear shift register sequence defined on  $GF(2)$  the  $m$ -sequence, we shall call the  $m$ -sequence defined on  $GF(p)$  ( $p > 2$ ) the generalized  $m$ -sequence. Many properties of the former can be directly applied to the latter, e.g., the shift addition property. However, for other aspects such as cross-correlation properties and modulation techniques, different treatment is required.

The  $m$ -sequences can be generated not only by methods of linear coding theory but also by applying the trace transformation to a set of ordered field elements to form a maximum-length sequence. This method provides simple expressions for the derived sequence of the generalized  $m$ -sequence and for a class of new CDMA codes.

Let  $Z$  be a non-zero element of  $GF(p^m)$ , then its trace is defined as [8]:

$$T_r(Z) = \sum_{i=0}^{m-1} Z^{p^i} \quad (5)$$

where  $T_r(Z)$  is the trace of  $Z$ . Its main properties are:

- $[T_r(Z)]^p = Z + Z^p + \dots + Z^{p^{m-1}} = T_r(Z)$ , where  $Z \in GF(p^m)$ . This implies that  $T_r(Z) \in GF(p)$ .
- $T_r(Z+Y) = T_r(Z) + T_r(Y)$ , where  $Z, Y \in GF(p^m)$ .
- $T_r(cZ) = cT_r(Z)$ ,  $c \in GF(p)$ .
- $T_r(1) \equiv m \pmod{p}$

Thus, trace is a transformation which projects the non-zero elements of  $GF(p^m)$  onto the base field  $GF(p)$ .

Let  $a$  be a primitive element of  $GF(p^m)$ ,  $a^{p^m-1} = 1$ , then all the  $(p^m-1)$  non-zero elements of  $GF(p^m)$  can be represented by  $a^k$  ( $0 \leq k \leq p^m-2$ ). If these elements are ordered according to  $k$ , then the maximum-length sequence on  $GF(p^m)$  can be expressed as:

$$T_r(a^k) = \sum_{i=0}^{m-1} a^{k p^i}, \quad 0 \leq k \leq p^m-2 \quad (6)$$

Example 4: Let  $p = 5$ , and  $f(\theta)$  be a primitive polynomial on  $GF(5^2)$ ,  $f(\theta) = \theta^2 + \theta + \theta^2$ ; let  $a$  be the root of  $f(\theta)$ , then we have  $a^3 = 3 + 4a$  and  $a^{24} = 1$ . From equation (5), we get:

$$T_r(Z) = \sum_{i=0}^{2-1} Z^{5^i} = Z + Z^5, \quad Z \in GF(5^2)$$

The field elements can also be represented by an  $(m-1)$ th order polynomial. Table 1 gives the non-zero elements of  $GF(5^2)$  and their corresponding traces. The last row of the table is the maximum-length sequence (0 1 4 4 3 4 0 2 3 3 1 3 0 4 1 1 2 1 0 3 2 2 4 2), which is the third shift (cyclic) of the sequence.

Table 1. Non-Zero Elements of  $GF(5^2)$  and Their Trace [ $f(\theta) = 2 + \theta + \theta^2$ ]

Coefficient	$\alpha^0$	$\alpha^1$	$\alpha^2$	$\alpha^3$	$\alpha^4$	$\alpha^5$	$\alpha^6$	$\alpha^7$	$\alpha^8$	$\alpha^9$	$\alpha^{10}$	$\alpha^{11}$	$\alpha^{12}$
$\alpha^0$	1	0	3	2	2	4	2	0	1	4	4	3	3
$\text{Tr}(\alpha^k)$	0	1	4	4	3	4	0	2	3	3	1	3	2
	2	4	2	0	1	4	4	3	4	0	2	3	2
Coefficient	$\alpha^{13}$	$\alpha^{14}$	$\alpha^{15}$	$\alpha^{16}$	$\alpha^{17}$	$\alpha^{18}$	$\alpha^{19}$	$\alpha^{20}$	$\alpha^{21}$	$\alpha^{22}$	$\alpha^{23}$	$\alpha^{24}$	$\alpha^{25}$
$\alpha^0$	4	0	2	3	3	1	3	0	4	1	1	2	2
$\alpha^1$	0	4	1	1	2	1	0	3	2	2	4	2	2
$\text{Tr}(\alpha^k)$	3	1	3	0	4	1	1	2	1	0	3	2	2

The properties of the generalized m-sequences are basically the same as those of the binary m-sequences, e.g., the "shift addition" property. However, the autocorrelation function of the former is multi-valued and has both positive and negative peaks; also, its calculation requires special treatment. In this paper, the autocorrelation function is calculated using Lee measure. The Lee weight of a code word is defined as the sum of the Lee weights of the individual digits.[9] Let the code word be  $c_0, c_1, \dots, c_{n-1}, c_i \in GF(p)$ , then the Lee weight of  $c_i$  is defined as:

$$W_L(c_i) = |c_i|, |c_i| \equiv \pm c_i \pmod{p} \quad (7)$$

and

$$0 \leq |c_i| \leq p/2$$

The Lee measure of the generalized m-sequence of Example 4 can be expressed as:

$$x = (0 \ 1 \ -1 \ -1 \ -2 \ -1 \ 2 \ -2 \ -2 \ 1 \ -2 \ 0 \ -1 \ 1 \ 2 \ 1 \ 0 \ -2 \ 2 \ 2 \ -1 \ 2)$$

Then, by using the general formula for computing periodic autocorrelation function:

$$a_i = \sum_{j=0}^{p-1} x_j, x_0, \dots, x_{p-1} \in GF(p)$$

one can calculate the correlation function to be

$$(\overline{50} \ 0)$$

It is easy to see that the correlation function is multi-valued and has both positive and negative peaks. If a generalized m-sequence is generated on  $GF(7)$ , then a five-valued autocorrelation function will appear.

## 2. A Class of Derived Sequences of the Generalized m-Sequence

The generalized m-sequence is suitable for applications where the channel alphabet table is an odd prime number such as multi-phase modulation or pulse position modulation. However, by applying a certain non-linear transformation to the generalized m-sequence, a binary sequence with pseudo random properties (satisfying the Baumert-Wang-Welch lower bound) can be derived. Because of the non-linear characteristics of the sequence and the fact that it is generated by a controllable non-linear transformation, it can be used for secure spread spectrum communication or for data encryption. We shall now discuss a method of generating the non-linear sequences of section II by applying a square residual transformation to the generalized m-sequence. The general theory of generation is given in Ref. [2]. In this paper we call this binary non-linear PN sequence with even length the generalized M-sequence.

It is known from the theory of finite fields that if  $p$  is a prime number, then there are  $(p-1)/2$  square (residual) elements in  $GF(p)$  and an equal number of non-square (residual) elements. The square elements are  $1^2, 2^2, \dots, (p-1/2)^2$ ; if  $p = 5$ , then the square elements are  $1, 2^2 = 4$ . If  $x$  is a non-square element, then  $x, x^2, \dots, x(p-1/2)^2$  are the entire non-square elements of  $GF(p)$ ; if  $p = 5$ , clearly  $2$  is a non-square element and then the entire non-square elements are  $2, 2 \cdot 2^2 \equiv 3 \pmod{5}$ . Therefore, the elements of  $GF(p)$  can be divided into three categories: square elements, non-square elements and  $0$ . By applying the following square residual transformation, one can transform a generalized m-sequence defined on  $GF(p)$  into a binary sequence on  $GF(2)$  (the treatment of  $0$  elements will be discussed later):

$$\begin{pmatrix} \text{square residual elements} \\ 0 \\ \text{non-square residual elements} \end{pmatrix} \rightarrow \begin{pmatrix} +1 \\ 0 \\ -1 \end{pmatrix} \quad (8)$$

Example 5: The generalized m-sequence in Example 4 can be transformed using (8):

$$\{x_i\} \rightarrow \{s_i\} = (0 + + + - + 0 - - - + - 0 + + + - + 0 - - - + -)$$

A square residual transformed sequence is actually ternary because it retains the  $0$  element. Therefore, if it is to be used on a binary channel, the  $0$  element must be properly treated. In addition, the period of a sequence will in general be changed by a square residual transformation. In order to understand the basic properties of a generalized m-sequence, it is necessary to address the following two problems.

a. The treatment of  $0$  elements in  $\{s_k\}$ . Ref. [3] suggests turning off the transmitter (i.e., no signal is transmitted) at the instant when  $0$  elements appear; however, this scheme not only increases operational complexity, but also results in loss of total signal power. In Ref. [2] the  $0$  elements are simply converted into "+"; this does not change the autocorrelation properties

of the sequence, it only reduces the number of negative peaks by 4. When the period is very long, this loss can be neglected, as shown in Figure 1.

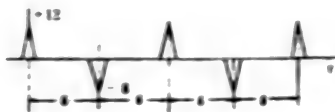


Figure 1. A Generalized M-Sequence With Period 12

b. The period of a generalized m-sequence. In Example 4, the period of the generalized m-sequence is  $5^2 - 1 = 24$ . But Figure 1 shows that the period of the derived generalized M-sequence is 12, not 24. This is the result of applying the square residual transformation. In fact, the period of a generalized M-sequence is determined by Theorem 1.

Theorem 1. The period of a generalized M-sequence is  $L = 2(p^m - 1)/(p - 1)$ .

To prove this theorem, it is necessary to introduce the following two lemmas.

Lemma 1. Let  $\{x_k\}$  be the longest linear recursive sequence on  $GF(p)$ ,  $n$  be the period of  $\{x_k\}$ ,  $\beta$  be the primitive element of  $GF(p)$ , then there exists a smallest divisor of  $n$ ,  $d$ , such that the following equation holds:

$$x_{i+d} = \beta x_i, \quad x_i \in GF(p)$$

Proof. Let  $x_i = T_r(\alpha^i)$ , where  $\alpha$  is the primitive element of  $GF(p^m)$ ,  $\alpha^n = 1$  and  $n = p^m - 1$ .  $x_{i+d} = T_r(\alpha^{i+d})$ , by using the trace property  $[T_r(\alpha^i)]^{p-1} = T_r(\alpha^{(p-1)i})$ , one can perform the following operations:

$$(\beta x_i)^{p-1} = \beta^{p-1} \cdot (T_r(\alpha^i))^{p-1} = 1 \cdot T_r(\alpha^{(p-1)i})$$

and

$$(x_{i+d})^{p-1} = [T_r(\alpha^{i+d})]^{p-1} = T_r(\alpha^{(p-1)(i+d)})$$

If  $\alpha^{d(p-1)} = 1$ , then the two right-hand sides of the above two equations are equal. Since  $\alpha$  is the primitive element, hence  $d(p-1) = n$ ,  $d = n/(p-1)$  is the smallest integer which satisfies  $x_{i+d} = \beta x_i$ . Q.E.D.

Lemma 2. Let  $p$  be an odd prime number, then  $\beta$  is not a square element of  $GF(p)$ .

Proof. The proof is by contradiction. Suppose  $\beta$  is a square element of  $GF(p)$ , then  $\beta^{1/2} \in GF(p)$ , and  $\beta^{1/2} = \beta^{t+1/2}$ . When  $p = 2t+1$ ,  $\beta^{1/2} = \beta^t \cdot \beta^{1/2}$ , hence  $\beta^t = 1$ . Since  $\beta$  is known to be the primitive element of  $GF(p)$ ,  $t = p-1$ , which is in contradiction to  $t = (p-1)/2$ . Therefore,  $\beta^{1/2} \notin GF(p)$ . Q.E.D.

Proof of Theorem 1. It is known from lemmas 1 and 2 that when and only when  $x_i$  is a square element of  $GF(p)$  and  $x_{i+d}$  is a non-square element, a square residual transformed sequence is odd-symmetric with respect to  $d$ , i.e.,  $s_i = -s_{i+d}$ , hence its repetition period is  $2d$ , i.e.,  $L = 2d = 2(p^m - 1)/(p - 1)$ . Q.E.D.

It follows from Theorem 1 that when  $p = 3$ ,  $L = p^m - 1 = n$ ; when  $p$  is any other odd prime number,  $L < n$ .

Figure 2 shows the procedure for generating a generalized M-sequence; the special non-linear transformation is not limited to square residual transformations.

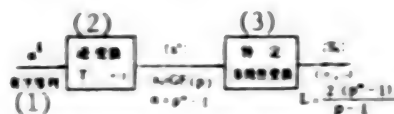


Figure 2. Generation of Generalized M-Sequence

Key:

1. Ordered array
2. Trace transformation
3. Special non-linear transformation

#### V. A Class of New CDMA Codes

The generalized m-sequence defined on  $GF(p)$  and the derived generalized M-sequence have been discussed in the previous section; in particular, the autocorrelation properties of the sequences are addressed. If these sequences are to be used in multi-address communication, the cross-correlation properties between them must also be considered. This problem has been studied in great depth for the case of binary fields, from which many sequences with good cross-correlation properties have been discovered, e.g., the Kasami sequence, the Bent sequence, and the Gold sequence; also discovered are the group character sequence suitable for multi-phase modulation, the sequence related to cyclic difference sets, and the dispersive linear FM sequence. In the following we shall introduce a class of new CDMA codes over  $GF(p)$  which was discovered by computer search using the idea of Gold.

##### 1. Optimum Pair of Generalized m-Sequence and the Generation of New CDMA Code

Let  $GF(p^m)$  be a finite field with  $p^m$  elements where  $p$  is a prime number; it is known from the general theory of finite fields that the field has  $\lambda(m)$  different primitive polynomials:

$$\lambda(m) = \phi(p^m - 1) / m \quad (9)$$

where  $\phi(n)$  is the Euler function

$$\phi(n) = \begin{cases} 1, & \text{when } n = 1 \\ \prod_{i=1}^t p_i^{a_i-1} (p_i - 1), & \text{when } n = \prod_{i=1}^t p_i^{a_i} > 1. \end{cases}$$

The  $\lambda(m)$  primitive polynomials can generate  $\lambda(m)$  maximum-length sequences. For example, in the case of  $GF(5^3)$ ,  $\lambda(m) = \phi(5^3 - 1) / 3 = 20$ ; in the case of

$\phi(3^5)$ ,  $\lambda(m) = \phi(3^5-1)/5 = \phi(2 \times 11^2)/5 = 22$ . Through computer search, it is possible to find an optimum pair from the  $\lambda(m)$  maximum-length sequences. Among the sequence set generated by shifted additions of the optimum pairs, the cross-correlation function between any two sequences and the autocorrelation function of any sequence are all subject to the constraint of fixed correlation bounds (using Lee measure).

**Example 6: New CDMA Code (obtained by computer search)**

(1) In  $GF(3^5)$ ,  $m_0(z) = 1+2z+z^5$  and  $m_7(z) = 1+z^2+2z^3+z^5$  constitute an optimum pair, whose generation logic is shown in Figure 3 (where the shift register has three states, multiplication and addition operations are all modulo 3, and  $x_i \in GF(3)$ ,  $n=242$ ). The autocorrelation and cross-correlation functions of the sequence set are bounded by  $\theta_{ii}, \theta_{ij} \in (0, \pm 18, \pm 36)$ .

(2) In  $GF(5^3)$ ,  $m_0(z) = 2+z^2+z^3$  and  $m_{13}(z) = 2+2z+3z^2+z^3$  constitute an optimum pair, whose generation logic is shown in Figure 4 (the shift register has 5 states; the multiplication and addition operations are modulo 5, and  $x_i \in GF(5)$ ,  $n = 124$ ).

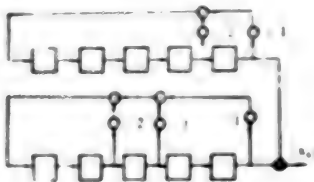


Figure 3. Generation Structure of a CDMA Code of  $GF(3^5)$

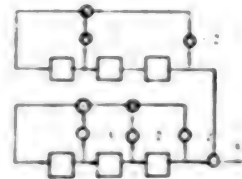


Figure 4. Generation Structure of a CDMA Code of  $GF(5^3)$

## 2. Discussion

At the present time, there is no systematic theoretical study of the relationship between multi-phase CDMA code and binary field CDMA code. In this section, we attempt to provide, based on known facts, several possible research ideas in order to stimulate the interest of research colleagues in this field. It is expected that within the foreseeable future, certain breakthroughs will take place in both research and application in this field.

a. It has been shown in the last section that optimum pair of the  $m$ -sequence exists not only over a binary field but also over a  $p$ -ary field ( $p$  is an odd prime number); this allows the generation of easily realizable new multi-phase CDMA code. Clearly, a unified formula can be found which applies to both cases, and the Gold sequence is only a special subset of this class of sequence set.

b. By extending the Baumert-Wang-Welch autocorrelation lower bound and the Welch cross-correlation bound to the  $p$ -ary field (the Welch bound has already considered the  $p$ -ary case, but the absolute value sign of the autocorrelation function should be removed), it is possible to predict the existence of new sequences, and to discover new spread spectrum sequences.

## VI. Concluding Remarks

The key points of this paper can be summarized as follows:

- a. This paper presents a new point of view on the properties of pseudo random sequences; i.e., binary sequences which reach the Baumert-Wang-Welch lower bound constitute the complete set of PN sequences. The equality of the number of "0" and "1" in the sequence and the probabilistic characteristics of the length of runs are necessary consequences of this proposal.
- b. This paper also presents the method of generating a class of non-linear binary sequences, i.e., by applying square residual transformation to a generalized m-sequence to obtain a generalized M-sequence.
- c. A proof of the existence of optimum pair in a generalized m-sequence is given, and the procedure of generating a class of new CDMA codes which can be applied to p-ary channels is discussed.
- d. By applying non-linear and linear transformations to the generalized m-sequence, one can obtain a sequence with expected correlation properties; it is hoped that further study in this direction can lead to a unified theory of spread spectrum sequences.

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3012/6091



## SYSTEM OF COHERENT FIBER-OPTIC COMMUNICATION

40080052b Beijing DIANZI XUEBAO [ACTA ELECTRONICA SINICA] in Chinese Vol 15 No 5, Sep 87 pp 104-105

[Article by Wu Yizun [0702 1744 1415], Tian Feng [3944 0023], Yu Tong [0827 1749], and Yang Xinwei [2799 1800 0251] of the Beijing Institute of Posts and Telecommunications. Received Mar 86, revised Jun 86]

[Text] Abstract: A coherent fiber-optic communication system (0.633  $\mu\text{m}$  wavelength) is introduced. This system employs two stabilized lasers working independently, and can tune intermediate frequency (from about 400 MHz to 2 MHz) arbitrarily. Until now, the coherent fiber-optic system which can tune IF arbitrarily is not yet reported. With this system selecting IF as 70 MHz and 30 MHz, an experiment in transmitting code signals is made, with a very satisfactory result. In our country this is the first experimental system in this field.

## 1. Introduction

Coherent fiber-optic communication is currently an important area of research on a global scale; it also points the direction for future development of fiber-optic communication systems. Research in this area began around 1980; however, description of a comprehensive coherent fiber-optic communication system did not appear until 1983. Prior to that time, the only reports were concerned with test results of certain component characteristics. Since 1983, a number of sophisticated coherent fiber-optic communication systems have been built, and research activities in this area have become a trend around the world.

The coherent fiber-optic communication system described in this paper is in the 0.633  $\mu\text{m}$  band because under present conditions, the semiconductor light source available in this country cannot meet the requirements of coherent fiber-optic communication. Since 1982, a number of 0.633- $\mu\text{m}$ -band systems have been developed by different countries around the world, and a paper introducing this type of system was presented at the 1983 European Conference on Optical Communication (ECOC). We have developed an experimental system using a He-Ne light source; experimental results show that its stability greatly exceeds that of similar systems reported in the literature. Specifically, its intermediate frequency (I.F.) stability is 70 MHz  $\pm$  2 MHz; the two

optical-frequency oscillators can operate independently without the need for tracking; and the I.F. channels can be tuned arbitrarily between 400 MHz and 2 MHz (in this experiment, the I.F. was tuned between 70 MHz and 30 MHz). This capability is not achievable by existing semiconductor systems, and no similar systems have been reported in the literature. Therefore, it is believed that the system described in this paper has some unique features which can be used in certain high-precision experiments.

## II. System Block Diagram

The block for this system is shown in Figure 1.

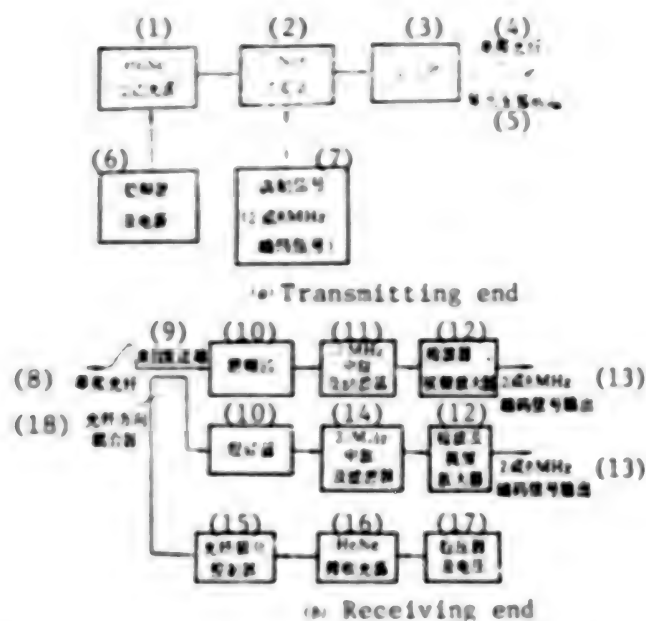


Figure 1. Block Diagram of a Coherent Fiber-Optic Communication System

Key:

1. HeNe transmitting light source
2. LiNbO<sub>3</sub> modulator
3. One-way device
4. Single-mode optical fiber
5. Output to receiving end
6. Frequency stabilizer and power supply
7. Modulated signal (2- or 8-MHz coded signal)
8. Single-mode optical fiber
9. From transmitting end
10. Frequency mixer
11. 70-MHz I.F. amplifier and filter
12. Detector, video amplifier
13. 2- or 8-MHz coded signal output
14. 30-MHz I.F. amplifier and filter
15. Fiber-optic polarization controller
16. HeNe receiving source
17. Voltage stabilizer and voltage supply
18. Fiber-optic directional coupler

The length of the single-mode optical fiber used in this system is 300 m. A relatively short optical fiber is used because in the visible-light frequency band, optical fiber suffers large attenuation and connection loss. In this system, the I.F. bandwidth is  $\pm 12$  MHz, the video bandwidth is 6 MHz, and a conventional circuit is used. To facilitate connections with conventional circuits, amplitude modulation is used in the experiment where the modulator is made of photoelectric material  $\text{LiNbO}_3$  (including waveguide type and body structure type). In view of optical loss considerations, a body modulation type structure is used in the experiment; also, because of the difficulty in connecting the tiny optical core of the  $0.633 \mu\text{m}$  fiber, great care must be taken in designing the connections and in selecting the components.

### III. Test Results

Because of the limited I.F. and video bandwidths, it is difficult to pass the 8-MHz coded signal through the system without a shaping circuit or decision circuit. Therefore, this system uses 2-MHz coded signals.

The waveforms in Figures 2-5 [photos not reproduced] show that the 2-MHz coded signals are well preserved by the system, with no error codes detected during the short-duration test. The 8-MHz signals show behavior similar to that in the 2-MHz case, but the pulse signals are merged into cosine waveforms, primarily due to inadequate I.F. and video bandwidths. Although Figures 2-5 only show the waveforms for the 70-MHz case, the waveforms for the 30 MHz I.F. system are very similar. In addition, we also measured the improvement in signal-to-noise ratio (S/N) between this system and an intensity-modulation/direct-detection system for two signal power levels  $P_s$ . Figure 6 shows the relationship between S/N improvement and local oscillator power. It is seen that an improvement of 15 dB or greater in S/N can be achieved.

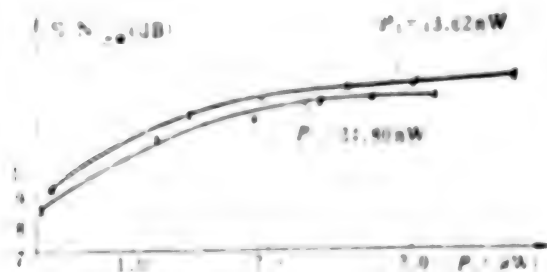


Figure 6

### IV. Concluding Remarks

The coherent fiber-optic communication system described here was certified at the ministry level in January 1986. The system allows arbitrary tuning of its intermediate frequency over a range of several hundred MHz, and a high degree of stability of system performance has been demonstrated. A significant amount of experience in coherent fiber-optic communication systems and in component development has been gained from building this system. This experience will undoubtedly be of great value for future work in this area.

# SINICIZED MINICOMPUTER SYSTEMS, VAX/CCVMS CHINESE-LANGUAGE INFORMATION PROCESSING SYSTEM

40080047 Beijing JISUANJI SHIJI in Chinese 8 Dec 87 pp 16-17

[Article by Li Deyi [2621 1795 3015]

[Text] Level and Objectives of Sinicization

What is a system with Chinese characteristics? How does one evaluate a system with capability to process Chinese characters? These are questions frequently encountered in converting minicomputers into machines with Chinese characteristics. To have Chinese characteristics, in general, means to have the capability to process Chinese characters in addition to the functions of the original software. However, as the work progresses, "Chinese characteristics" becomes ambiguous. To this end, we propose to define the degree of sinicization by different levels. It reflects the degree of sophistication in two aspects: (1) the extent to which Chinese characters are processed in the system, either in block, string, name, or individual character; (2) the extent to which Chinese characters are made compatible with the original software, either by peripheral or insertion means, or by uniform mixing and penetration.

There are three levels:

Level 1: The user enters Chinese characters as original data blocks from the periphery. They do not appear in the operating process. Or, Chinese characters are treated as character-string constants, appearing in the input/output statements and expressions for character-string constants.

Level 2: Chinese characters can be accepted at any level in the software. In addition, Chinese characters are allowed to flow freely. They can be used to name files, variables, records, fields, labels, procedures, paths, logics, lists or data by users, operators or system controllers. All system prompts (including error messages) can be expressed in Chinese characters. Thus, it provides the user with a development environment with full Chinese-character capability.

Level 3: Chinese characters are the system and language delimiters. This means that Chinese characters can be used in various command characters, mnemonic symbols, and system reserve words. The system internally processes Chinese information by the entire character, instead of by byte. It is a true system with Chinese characteristics.

Through analysis, we believe Level 1 is limited to the surface of the system. Because the core of the system is not changed, the input of Chinese characters may interfere with the convention set by the original program at different levels. Thus, in processing Chinese information, not only may the original software resources be sacrificed--particularly the foreign-language data base capability--but also the range of Chinese characters must be strictly limited. The overhead to avoid conflicts is also very high. It gives us the impression that we are shaving our feet to fit into a pair of shoes. Level 3 eliminates the language barrier at the man-machine interface. In reality, it is a Chinese computer. The engineering work is enormous and difficult. In addition, for programmers and system controllers, efficiency may be lowered if Chinese characters only are used. Therefore, we ought to set our objectives at Level 2. It not only can take full advantage of the functionality of the original program, but also satisfies the need to process Chinese information. Such a system meets the requirements of the users, as well as the programmers. The key is to be able to use Chinese characters in user-defined names. Specifically, the objectives are:

1. Preserve all functionality of the original English software and be compatible with the system.
2. Provide the users, programmers and system controllers with a unified interface for both English and Chinese and allow them to use either English or Chinese or a mixture of both to describe all kinds of data. It does not require any special syntax for the Chinese information. No excessive steps are used to process the Chinese characters.
3. Open all system resources to Chinese characters. All levels of the system, such as the core operating system, service programs, utility programs, high-level languages, program development tools and information management tools, must have Chinese-character processing capability. Chinese characters can be directly used in application programs without conversion or pre-processing. Moreover, Chinese characters must be used in an identical manner as English.

#### Strategy and Approach

What is the strategy to take now that the level is analyzed and objectives defined? We think there are two basic strategies.

The first one is to analyze the software of the entire VAX/VMS system by trying to understand the source program as a start. By analyzing the program line by line, we can figure out the data structure, control flowchart and interfaces of every module at each level. On the basis of thorough understanding, work can proceed to add Chinese characteristics to it. This is a difficult task which requires a lot of time and effort. This strategy can be called the white-box method. (It has been proven that the so-called black-box method which leaves the operating system alone and makes patches around it cannot meet the requirements for processing Chinese characters.)

The second strategy is to utilize existing Chinese-character terminal technology and recognizes the maturity of the software products based on the VAX/VMS operating system. Based on an analysis of the entire structure of the VAX/VMS system, the data structure and data flow (especially I/O flow) are closely examined from the top down. Each module is modified individually from the bottom up. Potential conflicts and possible solutions due to the presence of codes associated with Chinese characters are analyzed. Minimal changes are made in order to remain compatible with the original system. In some cases, after understanding its capabilities, it is not even necessary to understand its internal composition. The debugging, amending and test tools provided by the original program can be utilized to perform the modification and debugging. This strategy, although difficult and laborious, is nevertheless effective. It may be called the gray-box approach. Specifically, this method has the following special features:

- (1) A part of the effort is at the terminal and the other part is realized by the system. It fully utilizes the positive results of Chinese-adapted micro-computers: the peripheral equipment handles the input and output of Chinese characters to improve the processing efficiency. The focus is placed on the processing of Chinese characters by the minicomputer. The conversion from input codes to internal codes of the Chinese characters is handled by a modified VI terminal, or a Chinese-character terminal, or a microcomputer emulation terminal. The Chinese-character printer converts the internal codes to the address codes to be printed out in different fonts. Thus, the modified VAX/VMS system is not limited to a specific terminal or output device. In addition, it makes for easier linkup with other micro- or mini-computers in a network.
- (2) The VAX/VMS software structure offers multi-language character sets. Some 8-bit ASCII codes are available. The high address is 1. This provides a breakthrough point for Chinese characters. The loss of accessibility to the multi-language character sets offered by DEC is most probably completely acceptable to the users in China.
- (3) On the basis of an overall analysis of the VAX/VMS software structure, we have to understand the control flow and track down the data flow. Starting from the core, each module is modified to accept Chinese characters layer by layer from inside out. This is a thorough approach which will not lead to a high overhead. Once the inner layers are taken care of, it sometimes takes very little effort to complete the outer layers.

#### Testing System With Chinese Characteristics

Testing is an important step in the software development cycle. We consider testing to be equally important with development of software to accommodate Chinese characters. Moreover, the emphasis is placed on the modules modified for Chinese characters. The method adopted is as follows:

- (1) Testing is not only done after the software is developed but also at various stages in the development process.



(2) We insist that testing be done independent of the software development process. The purpose of testing is to find mistakes.

(3) The original English system is used as a reference in the testing process for comparison.

(4) To the extent possible, the testing tools in the original program should be used. The internal data structure may be modified to be used as automatic testing tools for the system with Chinese characters.

Testing primarily includes:

(1) Basic Function Testing. This is to prove that the functionality of the original program is not affected by adding Chinese characteristics. For instance, the user environment testing package (UETP) and installation verification package (IVP) provided by the original system can be used to test the operating system and various primary system software packages. These software packages can test process scheduling, file management, I/O management and drive, system environment and software environment, and primary functions of the programs.

(2) Testing Codes for Legality of Chinese Characteristics. It includes the testing of whether modules that ought to be modified are done and whether modified modules can accept the entire set of GB2312-80 codes for Chinese characters. We have to perform a coverage analysis and conduct an equivalence test for the GB2312-80 international codes. For each individual module, we may even conduct repeated testing.

(3) Testing Compatibility of Treatment of Illegal Characters After Modification. The modified system should treat the presence of illegal characters with the same error messages as the original English program to ensure the compatibility of the system.

(4) Overall Testing. We wrote a large number of programs to automatically test the functionality, interface and I/O of all modules.

#### VAX/CCVMS Chinese Information Processing System

The VAX/CCVMS Chinese information processing system is the result of modifying the VAX/VMS system based on the above thought.

Starting from the core of the operating system, the CCVMS system gradually modifies the VAX operating system, service programs and utility programs from the inside out. The modified program not only can accurately handle the input and output of Chinese characters but also allows the user to name files, lists, data structures and commands with Chinese characters. It serves as a good foundation for the modification of other information processing software and utility programs.

The CCVMS system also modifies other key software packages such as CDD, DTR and Rdb in the information management system of the VAX computer. The system not only can accurately accept and process Chinese characters but also can directly define and utilize Chinese data structure to provide a user-friendly interface. All interface relationship remains unchanged. The form management program FMS is modified to provide the user with a highly interchangeable form design environment. Regardless of whether it is the form itself or the data in the form, the text in the entire screen can accept Chinese characters by using the program TPU. It meets the Chinese text editing requirements. A Chinese character is used as a basic processing unit in the insertion, deletion, altering, finding and formatting of the text. Moreover, the original features of the TPU are preserved. It serves as a flexible Chinese character editing tool.

CCVMS is the first comprehensive Chinese information processing system developed for a minicomputer. It signifies that the modification of a large scale software package to handle Chinese characters has already reached an advanced level. This should promote the production of mini and microcomputers in China.

12553/08309



ACTIVE DEVELOPMENT OF CHINA'S CAD/CAM TECHNOLOGY ENCOURAGED

40080050a Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 23 Dec 87  
p 64

[Article by Zeng Xianzhang [2582 2009 4545]: "Actively Develop China's CAD/CAM Technology"]

[Text] 1. Introduction

Computer-aided design and computer-aided manufacturing (CAD/CAM) technology is a vital area in computer applications in engineering. It has been developed into an independent industry.

Other companies began to develop CAD/CAM technology in the 1950's and the technology is fairly mature. In the 1980's, as 32-bit microcomputer-based engineering stations became widely used, they gradually replaced the old CAD system which consists of a minicomputer with several graphics work stations. Moreover, the multi-user networking capability is greatly enhanced. This changes the situation where several people share a computer to one where everyone has his own computer, and moves in the direction of each individual using several computers. It is expected that CAD/CAM technology will be wide-spread. Furthermore, because CAD/CAM is becoming more and more integrated, there will be a number of computer integrated manufacturing systems (CIMS). With the introduction of artificial intelligence and expert system technology, the boundary between CAD and CAM will not be very clear. Design and manufacturing will be fully automated. Hence, the "A" in CAD/CAM is making a transition from "Aided" to "Automatic."

At the present moment, CAD/CAM is widely used in machine-building, electronics, construction and textile industries. The United States is still the pioneer and leader in the development and application of CAD/CAM technology, with Japan and Western Europe in second place. In those countries, CAD/CAM technology is being funded and supported by the government.

China began to develop CAD/CAM technology rather early. However, it was stagnant for a long period of time. In the early 1980's, the technology was revived. It is being used to various extents in aerospace, ship-building and construction industries. However, in comparison to other developed nations, the technology gap is about 10-15 years.

## 2. Technical Objectives and Focal Points in Developing China's CAD/CAM Technology

Under the guidance of the relevant department of our government, specific arrangements have been made in the Seventh 5-Year Plan to build a solid foundation for the development of China's CAD/CAM technology. It is expected that there will be a large number of accomplishments in CAD/CAM in the Eighth 5-Year Plan, essentially forming an independent industrial structure for CAD/CAM in China. This is an important development stage, and we hope that by the end of this century China's CAD/CAM technology will reach or approach the worldwide state of the art. However, because of the large number of industries, the relatively weak computer technology, and the shortage of CAD/CAM people, CAD/CAM will be used in major industries in proportion reached by developed nations in the early 1980's.

In addition to developing large, medium and small computer CAD systems, the key points in furthering CAD/CAM technology include development of the following: systems based on 32-bit microcomputer engineering work stations; software for computer networking and communications; relevant CAD support software such as geometric modeling, graphics input and engineering database; software standardization and commercialization; simulation and dynamic emulation technology, automatic programming technology for group technique (GT), computer aided design and digital control; application software, interfaces and control systems for CNC, DNC and FMS; artificial intelligence and expert system technology for CAD/CAM use; and, finally, integrated applications software packages for various industries.

Special care must be taken to standardize the software toward the international standard. We should stop developing software in a garage type of operation. Software should have all the engineering disciplines such as stages, system, plan and accountability.

## 3. Organization and Measures

In order to develop CAD/CAM technology in China in an open environment, it is suggested that the government should take full responsibility for investing heavily in key projects, training future talents, implementing the policy of combining technology import and domestic development, establishing a CAD/CAM center, strengthening international cooperation, and formulating software protection policy.

To develop our own CAD/CAM technology, China must stand up and build its own CAD/CAM industrial base. By the end of this century, we will be able to supply commercial systems software, support software and applications software in China, as well as to the rest of the world, forming a true CAD/CAM structure.

12553/9274

**'SIGNIFICANT' PROGRESS MADE IN MACHINE TRANSLATION, NATURAL LANGUAGE PROCESSING**

40080050b Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 23 Dec 87  
pp 65, 68

[Article by Guang Yi [1639 5030]: "China's Machine Translation Enters Applied Stage; Unprecedented Research Activity in Natural Language Processing"]

[Excerpts] At the 1987 international conference on Chinese information processing held in Beijing in August, machine translation and natural language processing attracted a lot of attention. The author participated in a group discussion on this subject and got the following impression: China's machine translation has already entered an applied stage. Research activities in the processing of Chinese language and characters are widespread, reaching into every field to an unprecedented scale.

In the group meeting, scholars in the world exchanged ideas concerning problems such as the methodology, theory, system realization and applications involved in the study of machine translation and natural language processing. Since the late 1970's, research activity in machine translation has become more active. Large machine-translation systems such as SYSTRAN are already available abroad. Since 1980, machine translation has been put to use in many countries. Commercial products are available (such as Japan). The situation is more or less similar in China. However, due to hardware and other issues, machine-translation systems for preliminary applications (such as the KY-1 model developed by the Academy of Military Sciences) and commercial systems (such as the "Tianyu" system developed by the Institute of Linguistics under the Chinese Academy of Social Sciences) are only available in the past 2 years. Although work in the area of natural language processing (primarily in Chinese) was begun late, it is developing with encouraging speed and nearing the trial stage.

**2. Breakthrough Made in China**

Significant progress has been made in machine-translation research and system development in China. Machine-translation systems have moved from the laboratory to the development and practical application stage, as evidenced by the pending introduction of commercial systems.

The Model KY-1 English-Chinese machine-translation system developed by Dong Zhengdong [5516 2182 3639] of the Academy of Military Sciences is a system of

considerable size already undergoing trial in China. The system has a glossary of over 60,000 words and phrases and about 5,500 syntax rules. The language syntax system of KY-1 is built on logic semantics. A special machine translation software SCOMT is used. Since the beginning of its trial, a large number of political, economic, military and computer-science documents have been translated. The system is also equipped with a data management software for the user to add the relevant language data, and has been used in mini and microcomputers. Translation speed varies according to the hardware: It can be as fast as 3,000 phrases per hour or as slow as 1,000 phrases per hour. Its accuracy is reported to be approximately 75 percent.

The "Tianyu" system (ECT-2) developed by Wang Guangyi [3769 1639 5030] at the Institute of Linguistics under the Chinese Academy of Social Sciences is an English-Chinese machine-translation system ready to be commercialized. The initial goal is to translate the titles and abstracts of AD and NASA reports from the United States and the INSPEK tape from Britain. The language data and software are independent by design. Thus, language-processing capability is enhanced and becomes more flexible. It allows the system to fully describe and process both general and special language phenomena and integrates both breadth and depth in language processing. Semantics and syntax are both important in language data processing. The focus is placed on the description and analysis of facts. There are 5,000 rules. After translating thousands of titles and abstracts, accuracy was found to be better than 80 percent. On the average, it takes 3 minutes to process an article on a microcomputer. The speed will be improved after optimization.

All the papers and reports presented have one thing in common--applications. While various methods and theories might be effective, research reports presented in the meeting clearly showed that there are still problems to be solved in machine translation. For instance, Pan Haihua [3382 3189 5478] of Huazhong Institute of Engineering and Wang Zhen [3769 3963] of Harbin Polytechnical University discussed their opinions on language comprehension and logic deduction in machine translation, respectively. The former even performed a test on the computer. Reports from Huang Jianshuo [7806 1696 3617] of the Huanan Institute of Engineering and Liu Yongquan [049] 8673 3123] and Qiao Yi [0829 3015] of the aforementioned Institute of Linguistics discussed difficult theoretical problems related to syntax and language processing. These reports have considerable significance and value, and are necessary for the development of machine translation in the long run.

Natural language processing started late in China. Nevertheless, the situation reflected in the meeting is encouraging. A great deal of progress has been made in the past 2 years in the study of Chinese language processing. The area of study has been extended from language comprehension to all levels of language processing.

Some progress has been made in the experimental study of expert systems specializing in Chinese language comprehension. The Model TK84 Chinese comprehension system developed by Fan Jiyan [5400 4949 3238] and De Zhimin [1779 1807 2404] of the Institute of Linguistics is a good example. In the analysis of

abbreviated sentences, it reaches a new level. In addition, it can generate more than one typeface.

The study of Chinese information processing has gone beyond modern-day Chinese. The ancient Chinese comprehension system developed by Li Jiazhi [2621 1367 3112] at the Institute of Psychology, Chinese Academy of Sciences was also tested on a computer. The purpose of the design is to test the ability of a computer to comprehend ancient Chinese and to express (translate) the results in modern Chinese.

In addition to the study of language comprehension and grammar specification, the meeting also offered some interesting subjects. For example, Zhu Jingguo [4376 2417 0948] used a computer to process information inscribed on bones at the Shanghai Museum. Deng Ximin [6772 1585 2404] conducted a comparison study of modern and ancient Chinese pronunciation with a computer at Huazhong Institute of Engineering. Huang Changning [7806 2490 1337] and Chen Qunxiu [7115 5028 4423] developed a Chinese computer interface at Qinghua University. This indicates that research activity in Chinese information processing has reached an unprecedented level, suggesting that breakthroughs are close at hand.

12553/9274

ADVANCES IN CHINESE-MADE MINICOMPUTERS OUTLINED

Beijing JISUANJI SHIJIE in Chinese 6 Jan 88 pp 16-17

[Article by Wang Zuyong [3769 4371 3057]: "Exploratory Advances in Chinese Mini-computers"]

[Excerpts] Attempts

Chinese-manufactured minicomputers have declined but the idea that the state once again closed the doors and forced computer users to use the same Chinese-manufactured computers as before is unrealistic. China's domestic computer market is now a part of the international computer market, the products of the world computer powers are contending with each other and competition is fierce. Can Chinese-manufactured computers win a place? In other words, can they come up with a Chinese-manufactured minicomputer that will be accepted by the users?

From September, 1986 to the end of 1987 the Ministry of Electronics Industry conducted a test at the North China Institute of Computer Technology and developed the NC12220 microcomputerized super-minicomputer within seven months. Then they trial-manufactured 20 of the computers in less than five months and formally named them the "Taiji 2220". By the end of 1987 over 100 SKDs were produced and several dozen systems were installed. A steady stream of orders for the Taiji 2220 computer is now coming in from domestic users, and in light of the current situation, the Taiji 2220 seems to have been preliminarily successful.

The "secret" of the victory in the first battle of the Taiji 2220 was three major conditions of acceptance by domestic computer users of Chinese-manufactured computers that the policy-makers discovered: first, functions must achieve current international levels; second, price must be close to that of similar foreign products; third, reliability and after-market service must be superior to similar foreign products. These three conditions were the design goals of the Taiji 2220. In the Taiji 2220 design process, all technical decisions which conformed to these three conditions were accepted and all which ran counter to them were abandoned. In line with this principle, we first had to abandon certain ideas which had become custom through long practice; for example, "Chinese-manufactured computers must be 'one hundred percent' Chinese-manufactured; at least the CPU must be Chinese-manufactured."



Everyone knows that CPU technology is now the peak of computer hardware technology and generally is realized using very-large-scale integrated circuits. If the CPU is to be Chinese-manufactured, then the functions of products produced at China's current technological level definitely cannot match those of similar foreign products. Furthermore, their development costs will greatly increase the price of Chinese-manufactured computers. Function and price would be out of line with the three conditions described above. Thus, the idea of a one-hundred-percent Chinese-manufactured computer must be abandoned and Chinese-manufactured computers must use foreign CPUs, chips and even cards.

Some may ask, then what meaning does a Chinese-manufactured computer have? In the example of the Taiji 2220, by using such key imported components as mature CPUs and large-capacity Winchester discs, the foreign exchange rate savings for the entire system can reach 67 percent. According to statistics, in 1986 we imported 138 similar computers at a total cost of US \$9.49 million. But at a foreign exchange savings rate of 67 percent, a similar number of Taiji 2220 computers produced in 1987 saved \$6.35 million in foreign exchange. Apart from the savings in foreign exchange, the vitality of \$6.25 million in output value injected into the computer industry cannot be overlooked either. Output for 1988 is estimated at 400 units, which, calculated at a similar rate of foreign exchange savings, amounts to \$18.41 million. This converts to 70 million RMB in domestic output value!

#### Inspiration

It cannot yet be said that the Taiji 2220 has thoroughly improved the Chinese-manufactured computer situation, or that it has won the confidence of Chinese users. Not all of the users who adopted the Taiji 2220 have done so voluntarily: some have because they had no foreign exchange, and some because they could not get approval for imports. Even so, the Taiji 2220 is a recent, powerful and fast Chinese-manufactured minicomputer. Its development experience should attract our attention.

We mentioned above that the key to the Taiji 2220's success was in breakthroughs in ideas. For a long time, Chinese-manufactured minicomputers have been subjected to problems of two trends. One is the demand that Chinese-manufactured computers be "one-hundred-percent" Chinese-manufactured and the other is the demand of "one-hundred-percent" imports. Although these two "one-hundred-percents" ran counter to each other, they were equally satisfactory in their own ways, but resulted in forcing the national computer industry to an impasse.

As a matter of fact, an actual minicomputer system was made of many different modules. Although this system was very advanced, not all the modules were of the highest level. Only some of the modules exceeded China's current design and production standards. If we do not dare to establish an entire system because of this obstacle, but import everything, we must import a great quantity of non-advanced items at the same time. This not only wastes a great deal of foreign exchange but also strangles national industry. On the

contrary, if we only import high-level components which we definitely cannot design and manufacture or whose design and manufacturing costs are too high, and at the same time must ourselves design and manufacture other parts, then we can only produce a Chinese-manufactured computer of "current levels." The Taiji 2220 is an attempt along these lines. This attempt shows that there is a vast world for Chinese-manufactured computer industry development between the two "hundred percents."

The Taiji 2220 established this model: domestically produced components and foreign-produced components can coexist in a Chinese-manufactured computer. Thus, the idea of "domestication" can be replaced by the ideas of "international sets" or "international cooperation."

Economists hold that there are three characteristics to current world economic development: (1) the new technological revolution, (2) systemic reorganization, and (3) international cooperation. By following the old path which has no way out, Chinese-manufactured minicomputers have consciously or unconsciously taken the new road of "international cooperation."

#### Tactics

These years what is most talked about in China's leading computer circles is how to promote the domestic computer industry. For this purpose a grand blueprint has been drawn up and a long-range plan has been formulated. The basic style of this blueprint and plan is to start from the foundation. A large, complete system has been built from raw materials to chips, from chips to entire computers, and from design environment to production line. The basic problem with this type of plan is that it is divorced from current reality, and divorced from current users. First, how many years will it take to build this system? How many years before a computer can be produced? What will domestic computer users use until then? They must use imported computers and computer products which have more powerful continuity than other products, so foreign computers will have the overwhelming share of the domestic market before the domestic product is built. Second, such plans will require state investment of several billions. What are the benefits of this investment? Who will make the decisions? These obstacles explain why these plans have been delayed.

This writer thinks that the promotion of the computer industry cannot start from the foundation, but should start with the product. We should fully utilize the good idea of "reform, opening up, and invigorating," fully utilize the advanced technological products provided by the international market (ICs and magnetic and optical media devices) and the technological strength and equipment which we already have domestically, to produce international-class products "shorter, better, faster." Our first orientation should be towards the domestic market, but we should simultaneously strive to increase product sales in the international market. We should accumulate capital by earning reasonable profits from the users of these computer products. With the market and with the capital, we can strengthen our own foundation and build excellent circulation. This type of reverse-development



model based on opening up can be achieved with little or no state investment and is more practical and less risky than the forward development model based on closing up.

#### Prospects

China is facing the challenge of the new technological revolution and there are a great number of potential users for computers, especially minicomputers. At the same time there is a minicomputer technological corps which can fight in China, so the basic conditions for minicomputer development are there. The key now is what development tactics we will use.

1987 was a year for Chinese-manufactured minicomputers to feel their way forward amid the new development tactics. This year the Taiji 2220 was produced. In 1988 we will continue to explore in this direction. According to estimates, in addition to the 2000 series, a minicomputer based on the internationally accepted 32-bit chip and with the NIX operating system user interface will make its appearance in 1988.

8226/9738

CSO: 40080053

New Microcomputer CAD/CAM System for Machinery Sets

40080061a Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese  
13 Jan 88 p 1

[Article by Xi [1585]: "A Full Functional and Highly Commercial  
Microcomputer Machinery CAD/CAM System"]

[Text] As the result of a joint effort involving Beijing Institute of Automation of the State Machine-Building Commission, Institute 303 of the Ministry of Aviation Industry, Institute 15 of the Ministry of Electronics Industry, First Division and Institute 710 of the Ministry of Astronautics Industry, Wuhan Institute of Shipping Engineering, and Central China Institute of Technology preliminary objectives of one of the projects in the "7th 5-Year Plan"--the development of a microcomputer CAD/CAM system for machinery set--have been accomplished. It was certified by the State Machine-Building Commission at the ministry level on 24 December 1987.

This PC-MECADS microcomputer CAD/CAM system is developed specifically for the design, analysis, drafting and manufacture of machinery products. It is an integrated, fully functional and highly commercial system to be used on microcomputers. The basic support environment of the system is either an IBM-PC/XT, AT, or a Chinese-made workstation in the Great Wall series such as the Model GW0520CH or GW286CAD. It uses the popular AUTOCAD version 2.18 2-and-2 1/2-dimension drafting software system to support graphics. It includes three utility systems and five general-purpose systems, i.e., the common-mechanical-parts design system, cold-die CAD/CAM system, mechanical-transmission design system, software package for the finite-element and boundary-element analysis of common mechanical parts, software package for design optimization and computation, processing software package for numerically controlled machining, software package for system development, and software package containing basic knowledge in machinery CAD/CAM. These software packages not only can run independently for different applications but also can be recombined into systems for specific applications. The system serves the practical needs of industries of all sizes. In addition to its applications for machinery design, it can be extensively

used, with slight modification and expansion, as a design aid in the electronics, construction, garment and light manufacturing industries.

The system has been tested for quite some time in a dozen places including the Beijing People's Machinery Plant, the Wuhan Institute of Iron and Steel Design, the Geological Survey Institute of the Ministry of Geology and Mineral Resources, and the Nanjing Chenguang Machinery Plant. It was reliable and could meet the need in production. Moreover, it brings significant technical and economic benefits which proves that the system has a bright future.

12553/09599

Computer Industry Plans for New Year Outlined

40080051b Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese  
13 Jan 88 p 2

[Article edited by the editor of the paper based on interviews conducted by reporters with directors and managers of plants and institutions:  
"New Plans for the New Year"]

[Excerpts] Establish the Concept of Commercialization Based on Science and Technology

Zhu Xinfu [2612 2450 3940], director of Huabei [North China] Institute of Computation and general manager of the Taiji [1132 2817] Computer Corp., pointed out that in 1987, Taiji Computer Corp. was founded and the first step it took was the commercialization of minicomputers. Economically, it is gradually taking shape. During the first few months since the founding of the Taiji Computer Corp., the Chinese-made Taiji 2220 minicomputer has been well received by the users and the prospect is encouraging. They plan to firmly establish the concept of commercialization in the new year, get into batch production, improve the quality of the product and work hard to lower the cost in order to satisfy the needs of their customers.

The product offered by Taiji Computer Corp. is based on the integration of research and production, with technology playing a leading role. It is one of a continuing series of products so that the user does not have to be concerned about equipment upgrade and obsolescence in the future. In 1988 they plan to introduce a new minicomputer to the market. Based on the Taiji 2220 machine, several typical applications systems will be developed for the users to select.

Based on requirements for building up the computer business, they not only made production a full-scale business but also formed a professional team in areas such as applications, sales, and service. The operating mechanism of the institute becomes more rational. The enthusiasm of the technical staff is full mobilized to serve the business and the customers. In the new year, they will provide a

complete range of high-quality services such as technical consulting, system design and contracting, personnel training, and maintenance and service to win the confidence of their customers.

#### Focus on Development and Scale Up Production

Xu Guoli [1776 0948 4409], manager of the Changzhou [1603 1558] Computer Plant, said that his plant made several advances in 1987 in manufacturing terminals for both Chinese and western-language characters, digital communications products, image-processing products and electromagnetic shields. Total gross product, sales income and profit are moving up at the same pace. According to financial statistics, the plant is one of the 10 major companies in the computer industry.

In 1988, they plan to continue to grow. In the development of new products, the focus is placed on three issues: development of a product series, standardization of products, and domestic manufacture of the products. The plant is working jointly with other organizations on five different Chinese/English terminals which are a part of the key projects in the "7th 5-Year Plan" at the provincial level. In the first half of 1988, they will introduce Guoguang [0948 0342] brand terminals in Models CJ-925, CJ-100, CJ-220, and CJ-240. These terminals are compatible with TV-925 [sic], VT-100, VT-220, and VT-240, respectively. In the second half of the year, a high-resolution Chinese-character image terminal for CAD use and a Chinese/English terminal for telecommunications will be available. In addition, they are actively developing a Chinese/English terminal that is compatible with the IBM 3270-series computers. In the area of digital communications networks based on wired and wireless modems, the plant is pursuing the development of a long-range network. In 1988, under the Guoguang brand name, they will introduce a baseband transmitter; FM-2400, FM-4800, and FM-9600 modems; and a communications-network diagnostic system. Moreover, they will establish a digital telegraph exchange network for several organizations. In 1988, they will move further toward domestic production of Chinese/English terminals and communications-network products, and begin to scale up into a regular business to take full advantage of the production capacity already in place. In addition, technology reform goals in the "7th 5-Year Plan" will be implemented to reach the level of 50,000 to 100,000 terminals per year, thus making use of economies of scale. They are confident that they have the capability to become the largest computer-terminal equipment manufacturer in China.

#### Combine Signal-Processing Technology With All Applications

Chen Chunxian [7115 2504 0341], general manager of China Software Technology Development Center, revealed that since 1985, in collaboration with experts at the Chinese Academy of Sciences, the center has been involved in development projects associated with the widely used 32-bit TMS320-series signal processors (including

32010/32020/320C25). After 2 years of effort, they have completed the <<ATD-320>> series of products with complete documentation and a variety of hardware boards and software packages. Some of the products are comparable to the 1986 international level among similar products.

In this new year, in addition to working with more advanced processors, efforts will be made to integrate a signal processor with a microcomputer to create a master-slave parallel-processing system where the signal processor is an accelerator. A small array system based on signal processors and global registers is also planned.

They hope to consolidate new signal processing technology with various applications so that the Four Modernizations will speed up with computer technology.

#### Use the New Development System To Serve the Customers

Xu Jian [1776 1696], director of Beijing Sanhuan [0005 3883], Institute of Computer Technology, told us that this institute is a small private organization, primarily engaged in developing a microcomputer-based development system. They sold close to 50 MDS-55 systems last year. Their product is well received by users in China.

In the new year, they plan to complete the emulation system for the 8-bit CPU and provide the user with 16-bit emulators and support systems for chips such as 8086 and 8088. In order to meet the increasing demand, they plan to install a production line and expand the labor force. They are also scheduled to set up service centers in Shanghai, central China, Sichuan, northwest China and northeast China to serve the customers.

12553/09599

# NEW VLSI COMPONENTS

40080072b Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 20 Jan 88  
 1

[Summary] Beijing, 20 Jan--Institute 47 of the Ministry of Electronics Industry (MEI) has recently developed two new components for microcomputer VLSI: the LCDA 0832 and the LC82C84A-5. These components, priority items for the Seventh Five-Year Plan, further the campaign for domestic microcomputer production.

The LCDA 0832 is a CMOS 8-bit, monolithic D/A converter. Its internal R-2R network uses CrSi thin-film resistance, and has good temperature-tracking characteristics, low power consumption, high precision, and a large operating temperature range. It can directly interface with the 8080, 8048, Z80 and other general-purpose microprocessors, and uses 20-pin dual in-line ceramic package (DACP) CMOS technology. The LC82C84A-5 high-performance clock generator/ driver, which provides a 5-MHz clock signal to the CPU and peripheral circuits, is a critical component in the 80C86 series of microcomputers. This circuit uses 18-pin DACP 3-micron silicon-gate HCMOS technology.

Testing with the DIC-8032 test system has shown that these two products meet performance standards given in MEI's directive "Overall Technical Specifications for Semiconductor ICs." Test results underwent evaluation in Shenyang a few days ago.

/06662



MEASUREMENT OF LASER-INDUCED DAMAGE TO  $\text{MgF}_2$  OPTICAL ANTIREFLECTIVE COATINGS

81112342 Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 14 No 9, 20 Sep 87 p 532

[Article by Xu Shizhong [6079 0013 1813] and Deng He [6772 0735] of the Chinese Academy of Sciences Shanghai Institute of Lasers: "Measurement of Laser-Induced Damage to  $\text{MgF}_2$  Optical Antireflective Film"]

[Text] We used an internationally-recommended standard method to measure the results of laser-induced damage to  $\text{MgF}_2$  optical antireflective film.

After amplification in a two-stage YAG laser amplifier, a laser beam emitted by a single horizontal model YAG laser oscillator was converged onto the sample by an aberrational non-spherical lens. The sample was installed on a precision sample holder which could be used for x, y, and z movement. This facilitated movement of the sample during the experiment and permitted the use of knife-edge scanning methods for precise measurement of the size of the light spot on the sample. An He-Ne laser was adjusted onto the same axis as the YAG primary laser beam. Besides being able to use it to regulate the entire optical system, it also served as a source of illumination during microscopic examination to facilitate precise determination of the damage.

The experimental parameters are shown in Table 1. Damage threshold values of three samples were measured during the experiments. An electron gun and a thermal evaporation technique were used to apply a single-layer  $\text{MgF}_2$  film on the YAG substrate of samples 1 and 2, respectively. Sample 3 was a single-layer  $\text{MgF}_2$  film on a  $\text{K}_2$  substrate.

Table 1. Experimental Parameters

Laser wavelength	1.064 $\mu\text{m}$
Laser model	TEM <sub>00</sub>
Pulse width (FWHM)	10ns
Diameter of light spot (1/1 <sup>2</sup> )	50 $\mu\text{m}$ *
Lens focal length	80.4mm

\*The diameter of the light spot on sample 3 was 65 $\mu\text{m}$

The damage experiments were carried out using a 1:1 standard method, meaning that a single laser firing was done for each site on the sample, regardless of whether or not the site was damaged. The results of the experiments are summarized in Table 2. It is apparent from Table 2 that the laser-induced damage threshold values for samples 1, 2, and 3 were, respectively,  $19 \pm 1.9 \text{ J/cm}^2$ ,  $23 \pm 7.0 \text{ J/cm}^2$ , and  $45 \pm 9.0 \text{ J/cm}^2$ . Sample 2 had the greatest range in distribution of damage, at 30 percent. This is related to the incompleteness of the film on this sample. It had a rather substantial number of defects when examined under a Normansky microscope. Table 2 shows that the damage threshold value of the film on the  $\text{K}_9$  glass substrate was about double that of the film on the YAG crystals. Thus, there is a definite need for more research on the effects of substrate characteristics on film damage.

Table 2. Results of Laser Damage Measurements

Sample Substrate		Damage threshold value	
		Energy density $\text{J/cm}^2$	Power density $\text{GW/cm}^2$
1	YAG	$19 \pm 1.9$	$1.9 \pm 0.19$
2	YAG	$23 \pm 7.0$	$2.3 \pm 0.7$
3	$\text{K}_9$	$45 \pm 9.0$	$4.5 \pm 0.9$

12539/06662

## SELF-FOCUSING FILAMENT, JET STRUCTURES IN LINEAR-FOCUSED LASER-PUMPED PLASMAS

40080066 Beijing ZHONGGUO KEXUE [SCIENTIA SINICA] in Chinese No 11, Nov 87  
pp 1169-1171

[Article by Xu Zhizhan [1776 5267 1455], Li Hongyi [2621 1738 3015], Lin Lihuang [2651 4409 3552], Zhang Weiqing [1728 0251 3237], Jiang Zhiming [3068 1807 2494], Meng Shaoxian [1322 4801 6343], Yu Jiajin [0151 0502 6651], and He Xingfa [0149 5281 3127], Shanghai Precision Optical Machinery Institute of the Chinese Academy of Sciences: "Self-Focusing Filament and Jet Structures in Linear-Focused Laser-Pumped Plasmas"]

## [Excerpts] I. Introduction

In recent years, the use of high-powered lasers to produce and heat high density plasma to realize X-ray lasers has attracted more and more attention.<sup>[1-4]</sup> The first realization of soft X-ray lasers in the laboratory<sup>[1,2]</sup> used laser plasma as the operating medium. So that a sufficiently large stimulated X-ray emission could be obtained in one line, a cylindrically focused laser irradiation target was used to form a linear plasma. The characteristics of coupling between the linear-focused laser and the plasma directly determined the operational state of the plasma operating as a gain medium. Thus research on the interaction between lasers and target plasmas and the characteristics of their becoming plasmas under linear-focused conditions has become a very important topic in X-ray laser research. However, it is regrettable that research in this area is very scarce and urgently needs to be done.

Recently, we conducted experiments on linear-focused laser-irradiated plane targets and cylindrical filament targets using the six-path neodymium glass laser equipment at the Shanghai Precision Optical Machinery Institute, exploring the interaction between laser and plasma in linear-focused geometrical configurations. In the experiment, we first observed self-focusing filament and plasma jet structures of linear-focused lasers in the plasma. The above phenomena clearly can seriously influence the state of linear plasma formed by the laser and thus can become an obstacle in X-ray laser research in which linear-focused laser-pumped plasma is the amplifying medium and ways must be found to overcome it.

## 11. Experimental Conditions

The experiment used a single laser beam or a single laser beam made up of two lasers in a six-path neodymium glass laser device. The laser beam was focused on the target through a combination of a cylindrical lens (plano-concave, concave surface curve radius of 800 mm) and a target lens which has been used in research (non-spherical surface,  $f/2$ ,  $f = 120$  mm), the linear-focusing focal length is 3-4 mm, but the width is approximately 60-140  $\mu\text{m}$ . The width of the 1.064  $\mu\text{m}$  laser pulse was generally 200-400 ps, but the laser energy was in the range of 1-20 J, and the corresponding average laser intensity on the target varied in the range of  $10^{12}$ - $5 \times 10^{13}$  W/cm<sup>2</sup>. By changing the cylindrical lens so that it was oriented toward the incident laser axis we could obtain a focal line on the target in any direction (such as horizontal or vertical). In firing at the target we used targets made of various materials (low  $z$ , medium  $z$ , and high  $z$ ): plane targets, thin film targets, sectional plane targets (such as twin-section targets made of carbon and gold) and cylindrical filament targets.

In the experiment, the set-up had a specialized direct-imaging optical diagnostic system using microscopic imaging of the two-dimensional space resolution by photographing along the plane lens the fundamental frequency ( $\omega_0$ , 1.064  $\mu\text{m}$ ) light and harmonic light ( $2\omega_0$ ,  $3/2 \omega_0$ ) of the emissions in the reflex direction. See Figure 1 for a diagram of the specific set-up. In experiments with a laser-irradiated cylindrical filament target (the laser's focal line after linear focusing overlapped the cylindrical target axis) and the plane target irradiated in a direction perpendicular to the target surface, we used a stimulated Raman backward scattering laser probe to shoot interferogram and shadow graph of the plasma. Using a light probe of laser plasma demanded that the pulse width be sufficiently narrow, synchronicity with the primary pulse be excellent, wave length be suitable, and that it be able to avoid interference with the plasma harmonic. Thus, we could not use forward Raman scattering<sup>[6]</sup> which is usually used abroad, but adopted instead backward stimulated Raman scattering which has better directionality and pulse compression to generate the probe square beam. Figure 2 shows the light path diagram of the laser probe system we based on the six-path neodymium glass laser device which we used for plasma diagnosis. This system used the pre-amplifier of one path of the six-path laser target device to generate the light source for the probe light. Since it and the laser's primary pulse came from the same oscillator, it resolved the issue of synchronicity very well. The 1.064  $\mu\text{m}$  laser beam went through a KDP crystal frequency multiplier, was converted into a 5320 Å green light, then entered a Raman box with a medium of dimethyl sulfoxide and produced a 6298 Å backward stimulated Raman light with energy above 200  $\mu\text{J}$ . The Raman red light pulse width was measured using a visible light streak camera. The narrowest was 40 ps. At this time the corresponding width of the 1.064  $\mu\text{m}$  primary laser target pulse measured by the streak camera was 250 ps, thus satisfying the demands of light probe diagnosis of plasma.

In addition, in this experiment we also had the following plasma diagnosis techniques: ion radiation was measured using a Faraday cylinder charge collector; space resolution and space integral X-ray spectrum were shot using a TIAP crystal spectrograph; and X-ray emission images of the target plasma were shot using an X-ray pin-hole camera.

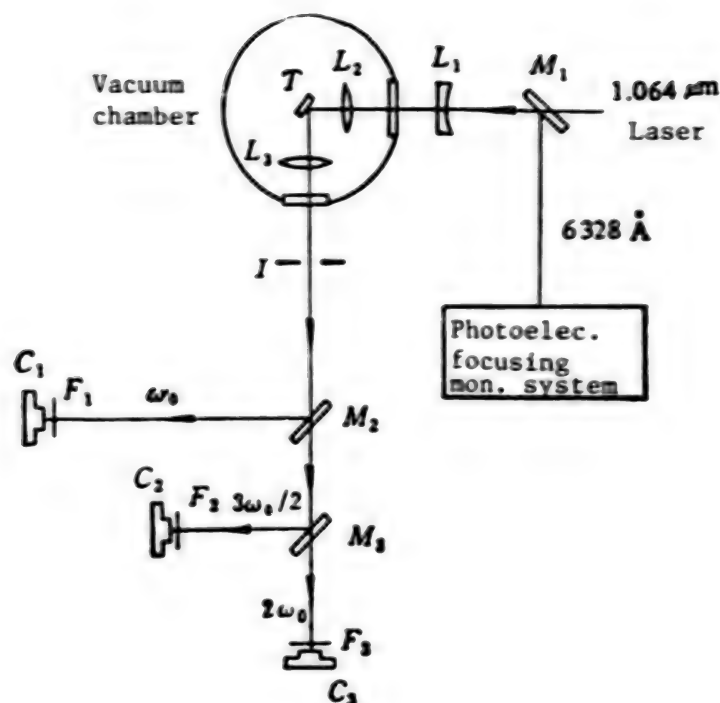


Figure 1. Optical Analysis System of Microscopic Imaging of Fundamental Frequency ( $\omega_0$ ) and Harmonic Wave ( $2\omega_0, \frac{3}{2}\omega_0$ ) of Reflex Emissions Shot Along the Lens Axis

- $C_1, C_2, C_3$  -- Camera black box
- $F_1$  -- Infrared filter
- $F_2$  -- 7100 Å interference filter
- $F_3$  -- 5320 Å interference filter
- $I$  -- Diaphragm
- $L_1$  -- Cylindrical lens
- $L_2$  -- Non-spherical surface target lens
- $L_3$  -- Imaging lens
- $M_1$  -- 1.064 μm transparent, 6328 Å reflex lens
- $M_2$  -- 1.064 μm fully reflex, 7093 Å and 5320 Å transparent plane mirror
- $M_3$  -- 7100 Å fully reflex, 5320 Å transparent plane mirror
- $T$  -- Target

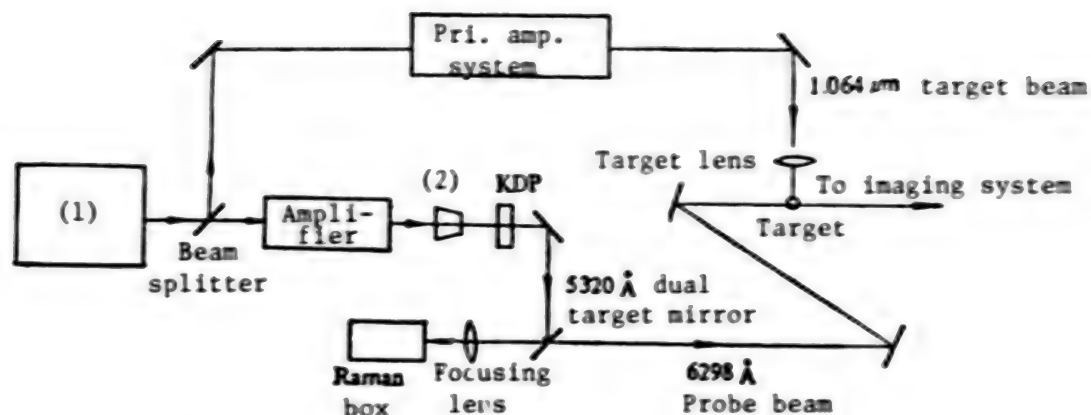


Figure 2. Diagram of Optical Path of Laser Probe System

Key:

1. Oscillator and common amplifier
2. Shrink hole telescope

### III. Conclusion and Discussion

We utilized direct imaging diagnosis of the two-dimensional space resolution (resolution was approximately  $10\text{ }\mu\text{m}$  in magnitude) of the target mirror's reflex laser, the first time we observed the important phenomenon of linear-focused laser splitting into light filaments in the plasma. In these experiments, the plane target was placed at an angle (in left and right directions), the included angle between the target surface's normal direction and the light axis direction of the incident laser was usually  $22^\circ$  or  $45^\circ$ ; the focal line of the linear-focused laser was perpendicular to the target surface. The experimental results showed that the above phenomenon generally appeared on targets of Au (atomic number  $z = 79$ ) plasma  $z$  material, and always appeared more clearly within areas of higher light intensity. Within these areas, laser intensity clearly was higher than the average value of light intensity in the entire laser focus area. To clarify the function of target  $z$ , we used a partitioned target of low  $z$  (C) and high  $z$  (Au) material, and adjusted the position of the laser focus on the target surface so that the upper half of the focal line irradiated the C and the lower half irradiated the Au. Only on the lower Au part could we clearly observe fine segmented filament structures in the target surface mirror reflex laser image; and often could also observe them clearly in the area of higher light intensity. The dimensions of the filaments created by splitting the laser were generally of a magnitude of  $10\text{--}20\text{ }\mu\text{m}$ , and often displayed a layered structure along the direction of the focal line. To compare them with the situation of the usual point focus which does not exist with a cylindrical surface lens, we photographed the mirror reflex laser image when a point-focused laser illuminates an Au plane target. Here we selected a large focal area and even a laser irradiation intensity which was close to the linear focused shooting of the target (average value ca.  $10^{13}\text{ W/cm}^2$ ). In the experiment, we also observed spot-shaped filament structures formed by laser splitting.



It is very clear that the above-described splitting of linear-focused lasers in plasma into filaments may have its source in hot self-focusing filament mechanism. Theoretical research[7,8] has pointed out that this thermally-induced filament mechanism is especially prevalent when the laser is of low intensity with a high  $z$  target. But high power laser beam spatial intensity profile is far from heterogeneous,[9] and actually can always provide full initial heterogeneity or intensity modulation, further amplification through the self-focusing effect and ultimately lead to the laser beam splitting into filaments.

We also used optical probe technology and in shadow imaging diagnosis of the target plasma observed cylindrical filaments in linear-focused laser radiated high  $z$  material (such as Cu) structures or with a plane target, very clear small-dimensioned plasma jet-filament structures.[10,11] Here, the diameter of the linear-focused laser-irradiated cylindrical Cu filament target was 140  $\mu\text{m}$ , the laser focal line coincided with the cylindrical target axis; and the probe laser beam shot the cylindrical plasma shadow graph from the side. The lateral spatial dimensions of the filament structure jets we observed in the plasma were 5-15  $\mu\text{m}$ . It should be noted that these plasma jets were recorded 2.88 ns after the laser pulses began. Although the source of these jets could be the intensification of the laser beam homogeneity due to the self-focusing and filament effect, it seems more likely that the source is some small-dimension instability of the plasma.[10-13] It should be pointed out here that the appearance of the plasma jets (which may be random time growth produced during the laser pulses) may have induced splitting of even initially very homogeneous laser beams and led to self-focusing filaments, thus becoming the mechanism for splitting the above-mentioned linear-focused lasers into powerful light filaments in plasma.

In addition, unlike the situation of the medium  $z$  target, when linear-focused lasers irradiate a low  $z$  (such as Al) film (thickness of 100  $\mu\text{m}$ ) plane target, through shadow graph imaging of the plasma by laser probe beams, we observed large-dimensioned (10-30  $\mu\text{m}$ ) plasma filament jet structures in the border areas of the plasma outside the laser focus region. The filament jets not only appear after the laser pulse stops, but are also in the border area of the plasma outside the laser-irradiated region (formed by lateral expansion through rapid thermal conductivity of low  $z$  material). Clearly it is even less able to be related to heterogeneity of incident laser and more likely to be due to other mechanisms of plasma instability.

The splitting into filaments of beam self-focusing and the filament jet structures of plasma discovered in this experiment when irradiating a target with self-focusing lasers will become an important issue in X-ray laser research using linear-focused laser-pumped plasmas as working matter. These phenomena will not only influence laser absorption efficiency, but also will damage the optimum working state of the plasmas necessary for implementing X-ray lasers. For example, there will be no way to produce the homogeneous linear plasma (with such parameters as suitable density and temperature) amplification medium demanded by theoretical designs. In particular, the target material used for implementing X-ray lasers is largely medium  $z$  and even high  $z$  material, for example, the first reports verified in a



preliminary way experiments on soft X-ray laser amplification<sup>[1,2]</sup> carried out using Se ( $z = 34$ ) and Y ( $z = 39$ ) and the typical value of laser irradiation intensity was ca.  $5 \times 10^{13}$  W/cm<sup>2</sup>, which is also close to the situation in the experiment in this paper. Thus it may be predicted that in soft X-ray laser experiments the phenomena discovered in this paper may very likely appear and thus create a serious problem. In fact, even in the recently reported preliminary experiments of the famous first implementation of a soft X-ray laser<sup>[1,2]</sup> also left problems which have not yet been clarified, i.e., the transition between  $J = 0$  and  $J = 1$  of highest gain neon-like ions predicted in theory was not observed. It is very clear that as X-ray laser research springs up vigorously and becomes deeper the interaction between linear-focused lasers and plasma which are its foundation, especially the mechanisms which produce such phenomena as self-focusing filaments and small dimension jet structures and research on methods to overcome them certainly will attract more and more serious consideration.

Participating in this research work were Comrades Fan Pinzhong [5400 0756 1813], Zhang Yanzhen [1728 3601 3791], Qian Aidi [6929 1947 1229], Zhang Wenqi [1728 2429 3823], Cao Jinzhou [2580 6855 3166], Yu Jian [0151 1017], and Ma Jinxiu [7456 6930 4423]. We thank our institute's Six-Path Operations Group for the support and help they gave to our experiment and we thank Comrade Zhang Zhengquan [1728 2973 3123] for providing the cylindrical lens for this experiment.

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SOME RESEARCH IN LASER-INDUCED SOLID SURFACE CHEMICAL PROCESSES

40090058b Beijing ZHONGGUO KEXUE (SCIENTIA SINICA) in Chinese No 11 Nov 87 pp 1191-1200

[Article by Qiu Mingxin, Zhou Zhengzhuo, Li Deng, and Shen Guangping of the Shanghai Institute of Laser Technology]

[Abstract] The use of argon laser frequency multiplication and the excimer laser for experimental research in solid surface chemical processes, such as metal layer sedimentation, compound layer sedimentation, photoinduction chemical photoetching, and laser chemically induced doping, are described and the mechanism of some of these processes investigated.

/06662

PARAMETRIC RESEARCH ON RAMAN FREE-ELECTRON LASERS

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[Article by Chu Cheng, Lu Zaitong, Shi Ruigen, and Wang Zhijiang, Chinese Academy of Sciences, Shanghai Institute of Optics and Fine Mechanics]

[Abstract] A parametric optimization experiment with the Raman free-electron laser we have developed is described and the best operating conditions for the device are presented. Under these conditions, the laser's performance is greatly improved: there is a quantitative increase in the electronic efficiency (during use of the iron-ring oscillator, it is now up to 0.8 percent; and for the magnetic oscillator, up to 1.4 percent), and the laser exhibits quite good tuning performance (wavelength tuning range is 5-9 nm for the iron-ring oscillator, and 6-12 nm for the magnetic oscillator). The experimental results are in good conformity with theoretical calculations.

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## OUTPUT PULSE PROPERTIES OF SHORT OSCILLATING CAVITY EXCIMER LASER STUDIED

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[Article by Qian Yujun [6929 5148 6511] and Shangguan Cheng [0006 1351 6134] of the Shanghai Institute of Optics and Fine Mechanics, and Cai Yingshi [5591 5391 2514] of the Physics Department, China University of Science and Technology: "The Investigation of the Output Pulse Properties of Short Oscillating Cavity Excimer Laser"]

[Excerpts] Abstract: The UV light preionized, Blumlein transverse discharge pumped XeCl excimer laser with cavity lengths of 7.5 cm and 20 cm can produce short laser pulse output with FWHM of 1.8 ns and 5 ns. The initial spike of the laser oscillations obtained by computer simulation of the rate equation is compared with the experimental results.

### 1. Introduction

High-power, narrow pulse width ultraviolet coherent light has great application potential in the study of fast dynamics, the optical pumping of short-lived atoms and molecules, and the enhancement of nonlinear optical effects. The usual UV preionized, Blumlein transverse discharge pumped excimer laser has a cavity length of about 1 m, a pulse half-width of about 10-20 ns, and a peak power of the order of 10 MW. Commercial short-pulse excimer lasers may produce XeCl laser pulses of 5 ns half-width and 1 MW in peak power.<sup>1</sup> In the short pulse technology the most direct and convenient method is to use a short cavity in the generation of single short pulses.

The short cavity technology makes use of the tunable transient effect of the short cavity. Under certain conditions, the light field in the cavity generates relaxation damping oscillations. The sharpest initial peak may be used in the suppression of the laser pulse. The physical basis for this operation is the interaction of the super threshold population inversion of the activated medium and the electromagnetic photon. This phenomenon was first observed in solid state lasers and then in semiconductor and dye lasers.<sup>2</sup> Theoretical studies were made on this effect.<sup>3</sup> In 1984, theory and experiments were extended to excimer XeCl lasers and laser oscillations of 1 ns half-width were produced. In this paper we present a detailed experimental and theoretical study of the short cavity. Using 7.5 cm to 20 cm long

resonance cavities, UV preionized Blumlein transverse discharge pumped XeCl excimer lasers can generate 1.8 ns to 5 ns half-width short pulses. Experimental results are in good agreement with theoretical simulation calculations.

## II. Short Cavity Laser Oscillation Theory

Using a two-level system model to describe medium activation of an excimer laser, the rate equation is as follows:

$$\frac{dn}{dt} = W(t) - \sigma nq - n/\tau, \quad (1)$$

$$\frac{dq}{dt} = \sigma nq - q/t_c, \quad (2)$$

where  $n$  is the excimer density,  $W(t)$  is the discharge pump rate,  $\sigma$  is the activation cross-section,  $q$  is the photon density in the cavity,  $t_c$  is the photon lifetime in the cavity,  $\tau$  is the spontaneous emission life, and  $c$  is the speed of light in the medium. Since the lower level of an excimer laser may be regarded as empty,  $n$  is also the population inversion density of the excimer laser. Since the unique feature of the short cavity is a small  $t_c$ , the output pulse half-width is far greater than  $t_c$ , and transport effects are therefore ignored in the equation.

Under the small signal approximation, Equations (1) and (2) lead to the relaxation oscillation condition<sup>3</sup>:

$$\tau/t_c > [m^2/4(m-1)], \quad m = W_0 \sigma t_c \tau,$$

where  $W_0$  is the maximum value of  $W(t)$  and  $m$  is the super threshold pump ratio. The equation above becomes:

$$\frac{2\tau}{t_c} \left[ 1 - \sqrt{1 - \frac{t_c}{\tau}} \right] < m < \frac{2\tau}{t_c} \left[ 1 + \sqrt{1 - \frac{t_c}{\tau}} \right]. \quad (3)$$

The necessary condition of relaxation is  $t_c < \tau$ . Parameters  $t_c$  and  $W_0$  determine the properties of the output pulse.

For convenience, (1) and (2) are written as dimensionless equations:

$$dN/dT = P(M - N) - PNQ, \quad (4)$$

$$dQ/dT = (N - 1)Q, \quad (5)$$

where  $T = t/t_c$ ,  $N = n/n_0$ ,  $M = W(t)/W_0$ ,  $Q = q/q_0$ ,  $P = t_c/\tau$ ,  $n_0 = 1/(\sigma t_c)$  (threshold population inversion density),  $W_0 = 1/(\sigma t_c \tau)$  and  $q_0 = 1/\sigma \tau$  (average photon density). Using a finite element method:

$$du(i)/dT = [U(i) - U(i-1)]/\Delta T, \quad (\Delta T \rightarrow 0),$$

a computer simulation value is achieved by regression. The initial conditions of the calculation are  $N(1) = 0$ ,  $Q(1) = \alpha\tau$  (calculation begins with one photon), and the pump pulse is a Gaussian pulse with a half-width of  $\tau_0$ :

$$M(t) = m \cdot \exp\{-4 \ln 2 [(1-1) \Delta T \cdot t_c / \tau_0 - 2]^2\}. \quad (6)$$

where  $\Delta T = 4 \cdot \tau_0 / M_0 t_c$ . The following parameter values were used in the calculation:  $\tau = 1.4$  ns,  $\sigma = 4.8 \times 10^{-16}$  cm<sup>2</sup>,  $c = 3 \times 10^{10}$  cm/s, and  $M_0$  is the maximum number of points. The calculated results are as follows:  $A_3 = m$ ,  $A_4 = \tau_0 (10^{-9} \text{ s})$ ,  $A_5 = t_c (10^{-9} \text{ s})$ . In the figure  $Q$  is  $q$ , in units of cm<sup>-3</sup>,  $G$  refers to  $N$ , and  $EM$  refers to  $m$ . The unlabeled figure is the pulse shape of the Gaussian pump.

1. When  $t_c = 0.028$  ns the ordinary solution may be obtained only if  $M_0$  takes on the value of 1,000. The various waveforms are shown in Figures 1 and 2. These figures show that, as the pump level increases, relaxation oscillations become more and more prominent, the number of oscillations increases and the initial peak becomes narrower. The separation between the peaks remains a constant and may be regarded as the oscillation period. The overall envelope is an exponential decay. For the same pump level the width of the pump pulse has a large effect on the laser pulse. The greater the value of  $A_4$ , the more prominent are the oscillations. At  $A_4 = 5$ , the half-width of the laser pulse is 0.2 ns; at  $A_4 = 20$ , the half-width is 0.4 ns.

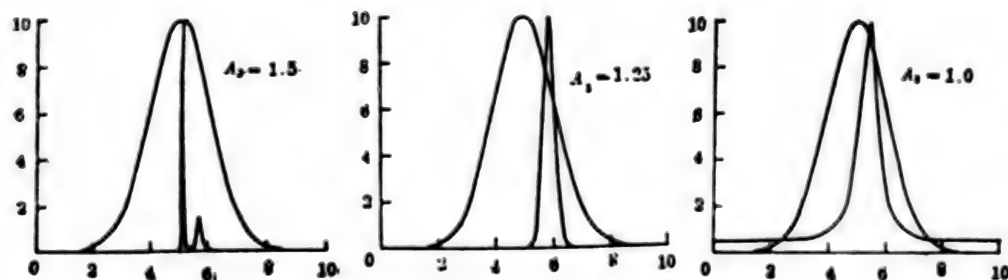


Figure 1. Oscillating pulse shapes  
 $A_4 = 10$ ,  $A_5 = 0.028$

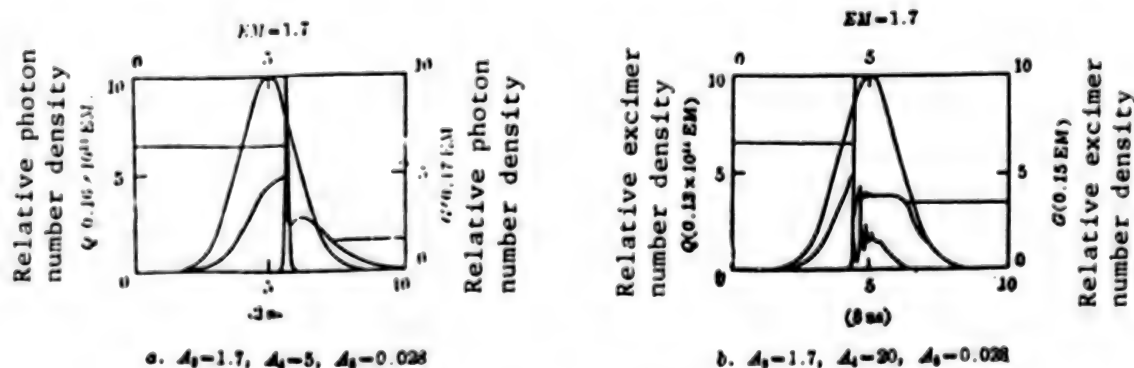


Figure 2. Pulse shapes

2. The output pulse shape is also calculated for  $t_c = 0.18, 0.33, 0.6$ , and  $0.9$  ns and  $M_0 = 400$ . Figure 3 shows the waveform for  $t_c = 0.18$  ns. As can be seen, the leading edge of the laser pulse rapidly becomes steep as the pump level increases. The trailing edge forms an increasingly stronger following pulse and the change in the half-width of the initial pulse is very small. As  $t_c$  increases, the trailing pulse becomes higher and broader, and the peak becomes less obvious.

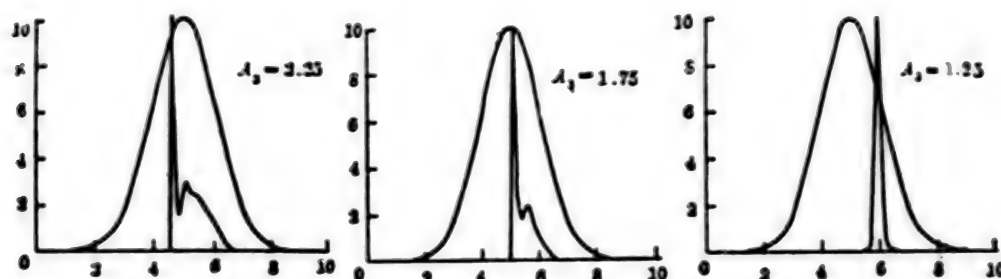


Figure 3. Oscillating pulse shapes  
 $A_4 = 20, A_5 = 0.18$

3. When  $t_c = 2.8$  ns,  $P = t_c/\tau = 2$  and Equation (3) predicts that no relaxation oscillation will occur under the small signal approximation. The calculated results are shown in Figures 4 and 5. Calculations also show that there will not be a sharp peak. The leading edge of the pulse is steep and the trailing edge coincides with the pump pulse. No compression effect will take place.

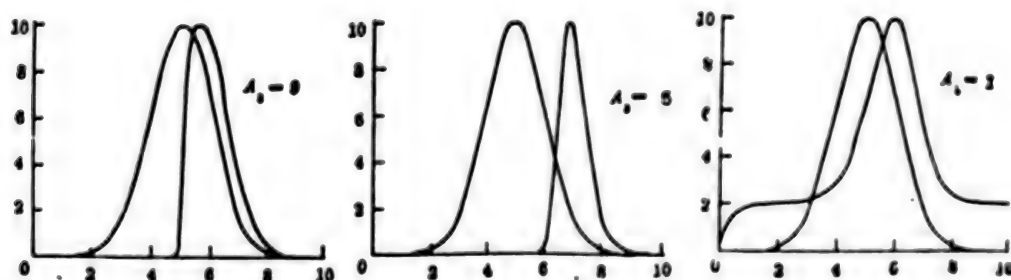


Figure 4. Output pulse shapes  
 $A_4 = 20, A_5 = 2.8$



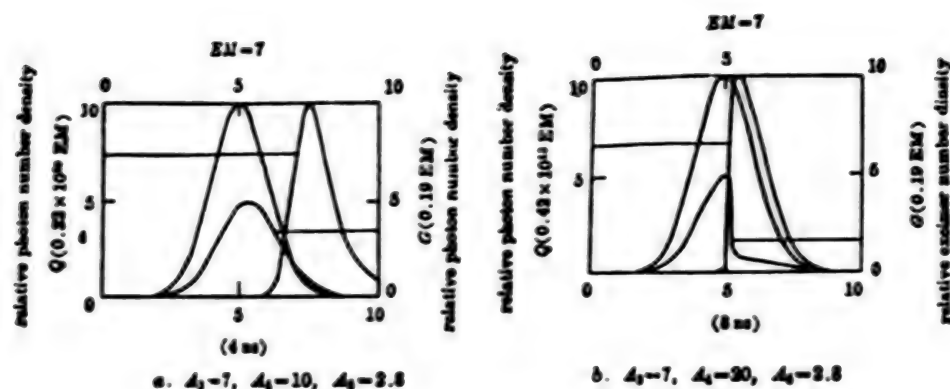


Figure 5. Pulse shapes

### III. Experimental Results

#### 1. The Experiment

The XeCl discharge tube is a 10.5 cm long epoxy cylinder with an inner diameter of 84 mm and outer diameter of 120 mm. The preionization discharge electrodes are two pins that form two strong spark gaps to provide sufficient UV preionization. The spark gap is 1.5 mm and is located 15 mm above the main discharge electrodes to avoid direct discharge to the main electrodes. The gap of the main electrodes is 7 mm and the effective discharge volume is  $50 \times 7 \times 2 \text{ mm}^3$ . The screw holes are all sealed with rubber O-rings. In order to shorten the cavity length as much as possible, the cavity heads extend inward. At the minimum cavity length of 74 mm, the electrodes are separated from the mirrors by only 7 mm. The cavity length cannot be any shorter because high voltage breakdown will occur in cavities of any shorter length.

To obtain short output pulses, in addition to reducing  $t_c$ , the discharge pulse width must also be small. The key is to reduce the induction of the discharge loop. In the experiment metal plate triple pole ball gap switches are used. The discharge gap is 5 mm and the pressure is 1.2 atm  $\text{N}_2$ . The main discharge ball gap switch is 3 mm and the pressure is 4 atm  $\text{N}_2$ . The plate capacitor is 0.6 mm thick and the dielectric is a 50-mm-wide polymer thin film. The total pressure of the mixed gas is 5 atm and the discharge voltage is about 25 kV. The discharge circuit is the usual Blumlein circuit.

#### 2. Results

A GD-5 high current photoelectric tube is used as a detector. The waveforms are observed on a 400 MHz storage oscilloscope and the response time of the detection system is 1.5 ns.

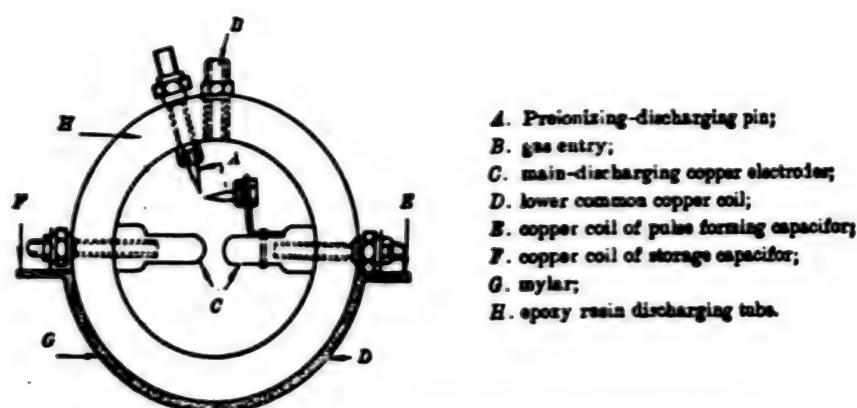


Figure 6. Diagram of discharging tube cross-section

Short pulse excimer lasers with five different  $t_c$  are tested. The capacitances are  $C_1 = 0.6$  nF,  $C_2 = 0.3$  nF,  $C_3 = 10$  nF.  $t_c$  is calculated using the formula  $t_c = -2L_c / [O \ln(r_1/r_2)]$  where  $L_c$  is the cavity length and  $r_1, r_2$  are the reflectivities of the front and aft mirrors. The gas mixture ratio is HCl:Xe:He = 5.5:50:3800 Torr. The results are listed in Table 1. The comparison between experiment and theory is given in Table 2.

Table 1. Short Pulse Experimental Results Using Short Cavities

$L_c$ (cm)	$r_1$ (%)	$r_2$ (%)	$t_c$ (ps)	discharge voltage $U$ (kV)	shape Fig.	FWHM (ns)	real FWHM resulted from deconvolution (ns)
74	90	8	187.5	26	Fig. 7a	2.3	1.8
74	90	23	316	24	Fig. 7b	3.1	2.7
132	90	8	334	24	Fig. 7c	3.3	2.9
132	90	23	600	24	Fig. 7d	3.7	3.35
200	90	23	954	24	Fig. 7e	4.3	4

Table 2. Comparison of Results

$t_c$ (ns)	$t_c = 10$ ns theoretical value		$t_c = 20$ ns theoretical value		experimental value (ns)
	$t_c$	FWHM (ns)	$t_c$	FWHM (ns)	
0.18	2	1	2	1	1.8
0.33	3.5	1	3.5	1.24	2.9
0.6	3.5	2	3.5	2.8	3.35
0.9	3.5	4	3.5	5.2	4
2.8	7	8.4	7	10.8	8.5*

\*This result is obtained from a general XeCl excimer laser.  $r_1 = 85$  percent,  $r_2 = 8$  percent,  $L_c = 100$  cm,  $t_c = 2.5$  ns. Main discharge voltage is 26 kV and the component of gas mixture is HCl:Xe:He = 6:40:2280.

The agreement is relatively good. The discharge pulse width is therefore estimated to be in the range of 10-20 ns. The agreement of  $A_3$  is not good and other factors must be considered.

#### IV. Conclusions

In this work we obtained short cavity XeCl excimer laser output with an effective discharge length of 50 mm and cavity length of 70 mm. The output pulse half-width is <2 ns and the pulse width gradually increases for  $t_c = 0.33, 0.316, 0.6$  and  $0.9$  ns. Theoretical interpretations are given in terms of computer simulation numerical solutions based on the rate equation. The half-width of the output laser pulse is greatly suppressed by the initial sharp peak in the relaxation oscillation when  $t_c \ll \tau$ .

The authors thank Chen Yuming and Dou Airong for their assistance with the experiments.

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9698/6091

500W YAG LASER DEVELOPED

40080069b Beijing ZHONGGUO DIANZI BAO in Chinese 18 Dec 87 p 3

[Article by Li Qiongrui [2621 8825 3843]: "500W YAG Laser Successfully Developed"]

[Text] The 11th Institute of the Ministry of Electronics Industry recently raised the output power of a CW YAG laser to 400-500 Watts by using two pumping lamps and by putting two laser rods in series. Maximum power is 517 Watts and it operates with stability for 30 minutes. The total conversion efficiency is 3.5 percent.

The high-power solid continuously working laser is a practical light source in laser processing and medical laser applications. As it is compact and easily coupled with an optical fiber, it is also used in science and technology, as well as in industry. It is also a target item in the "Seventh 5-Year Plan." It is not a trivial matter to build a 500W multi-mode continuous YAG laser; many technical breakthroughs are required. For instance, the conversion efficiency of the device must be improved, high-quality, large YAG crystals suited for continuous operation must be obtained, a heavy-duty long-life optical pump must be developed, the issue of cooling the laser and other parts under continuous high-power operation must be resolved, and problems associated with the durability of various thin-film components and the stability of the laser must be solved. As a result of their effort, the technical staff at the 11th Institute finished two laser devices of different design, creating favorable conditions for applications for high-power solid lasers in China.

12553/06662

ELECTRON MOVEMENT IN FELS

40090059a Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 15 No 1, 20 Jan 88 pp 1-4, 21

[English abstract of article by Fang Honglie [2455 3530 3525], et al., of  
Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Text] The movement of electrons in free electron lasers (FELs) is analyzed using the theory of relativistic quantum mechanics, and a rigorous analytical solution of the Klein-Gordon equation has been obtained under the condition of a helical magnetic field for pumping. The results show that the gain saturation of free electron laser light comes from the effects of the high order bunch and dibunch effect.

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MINIATURE FREE ELECTRON LASER--ELECTRIC UNDULATOR

40090059b Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 15 No 1, 20 Jan 88 pp 9-11, 8

[English abstract of article by Song Yu [1345 3603] of the Institute of High  
Energy Physics, Chinese Academy of Sciences, Beijing]

[Text] A new principle for free electron lasers is proposed for the first  
time through the very strong periodic potential caused by the spontaneous  
polarization of ferroelectric single crystals. According to this principle,  
a miniature, inexpensive and effective free electron laser at high frequency  
may be designed. It is technologically feasible.

9717

DAMAGE ACCUMULATION ON OPTICAL COATINGS

40090059c Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 15 No 1, 20 Jan 88 pp 22-25, 62

[English abstract of article by Shi Zhengrong [2457 2973 2837], et al., of  
Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Text] Damage experiments on  $\text{TiO}_2$  and  $\text{ZrO}_2$  coatings show that the thresholds of coatings induced by single or multiple shots increase monotonically as the coating absorptions decrease. The main factor inducing damage to coatings is the absorption of the coatings, including inherent absorption and that created by the coating inhomogeneities. The coating damage induced by multiple shots shows some cumulative effect of micro-damages.

9717



STOKES, ANTI-STOKES LIGHT GAINS IN STIMULATED FOUR-PHOTON MIXING IN OPTICAL FIBER

40090059d Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 15 No 1, 20 Jan 88 pp 30-36, 42

[English abstract of article by Wang Qi [3769 1142], et al., of Shanghai University of Science and Technology]

[Text] Photographs have been taken for the first time of two and three Stokes-anti-Stokes mode pairs appearing simultaneously in stimulated four-photon mixing (SFPM). Using the semiclassical approach, the coupled wave equation for SFPM in optical fibers is derived with regard to the Raman resonance and the fiber guiding property, and the coupling coefficients given by Stolen, et al., are corrected. The Raman resonant SFPM gains and the relationship between SFPM and SRS are investigated. The ratios of anti-Stokes to Stokes light intensities in the phase-matching and phase-mismatching conditions and the expression for the Raman upper-level molecular number in SFPM are found.

9717

**NARROW BANDWIDTH, HIGH SPECTRAL PURITY, HIGHLY-EFFICIENT DYE LASER OSCILLATOR-AMPLIFIER SYSTEM**

40090059e Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 15 No 1, 20 Jan 88 pp 47-49

[English abstract of article by Jiang Jinquan [3068 6930 3123], et al., of  
Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Text] A dye laser oscillator-amplifier system with narrow bandwidth, high spectral purity and high efficiency has been developed. A linewidth of 700 MHz (single longitudinal mode) has been obtained at  $\lambda = 600$  nm. The conversion efficiency is 13 percent and the S/N ratio is 0.25 percent (at  $\lambda = 591$  nm). A conversion efficiency of up to 15 percent has been obtained.

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## FUJIAN'S ELECTRONICS INDUSTRY DEVELOPING APACE

## Industry Growing Quickly

40080024 Beijing RENMIN RIBAO in Chinese 10 Sep 87 p 2

[Article by Li Feng [4539 7364]: "Fujian's Electronics Industry Developing Quickly"]

[Text] The sky is still the same, and so is the land. The only differences are that opening up the outside world, policy preferences, reliance on technology imports, and an accelerated technical pace in enterprises have made Fujian's electronics industry take off. Now, Fujian Province has the largest electronic instrument and materials company and the most complete electronics product lines in China. Fujian has several enterprises famous throughout China, including the Fuer Company, Xinhua Company, Fuxin Picture Tube Plant and so on. The gross value of output in the electronics industry in Fujian surpassed 1 billion yuan in 1985, eight times the 1980 figure. The gross value of output may surpass 1.2 billion yuan in 1987, while foreign exchange earnings may exceed \$20 million.

The gross value of output in Fujian's electronics industry was only 130 million yuan in 1980. Reforms and opening up have invigorated Fujian's electronics industry. From Fuzhou City to Putian, Quanzhou, and Zhangzhou to Xiamen and other coastal cities, all are eligible for preferential policy treatment for importing advanced foreign technologies with low interest loans, which has motivated the initiative of enterprises for self-transformation. They have made full use of local advantages, relied on their own capital and loans, and absorbed foreign capital. During the last few years of the Sixth 5-Year Plan, the enterprises invested 150 million yuan in technical transformation and 20 million yuan in capital construction to import technology and equipment, and they have assimilated them as well.

Now, two-thirds of Fujian's enterprises have carried out technical transformations and technical standards have been improved substantially. They have increased the variety and expanded the scale of products. Production capacity for televisions, radios, and calculators now exceeds 1 million units, and a preliminary scale has been attained in microcomputer, video recorder, and intercom production. There has been even greater growth in electronics components. The Fujian Province Computer Company has been among China's leaders in value of output for the past 2 or 3 years.

## New Force in Electronics Industry

40080024 Fuzhou FUJIAN RIBAO in Chinese 22 Oct 87 p 1

[Article by reporters Yu Wensheng [3226 2429 3932] and Ou Yongshan [2962 3057 1472]: "Fujian's Electronics Industry: A New Force Comes to the Fore"]

[Text] Fujian Province's electronics industry is a new force which has attained prominence and moved onto the path of vigorous development in the past 8 years. During the Sixth 5-Year Plan, the industry grew at an annual rate of 51.7 percent, which was higher than the 23.3 percent rate of growth in China's electronics industry as a whole. The gross value of output was 1.05 billion yuan in 1985, a 13.1-fold increase over 1978. Taxes were 94.23 million yuan, up 10-fold. The gross value of output in 1987 may exceed 1.4 billion yuan. The electronics industry has become a main pillar of the national economy in Fujian Province. This vitality followed the overall principle of "reform, opening up, and invigoration."

### I. Readjustments in Industrial Structures Create a New Situation

Before 1978, electronics enterprises in Fujian Province operated mainly on the "three small lines" and produced mostly military goods. To adapt to the need to open up, the industry has focused on "two shifts." Industrial deployments have shifted from the interior to the coast. Eight key enterprises have moved to coastal regions and central cities, and several new enterprises have been built in the Fuzhou Development Zone, Xiamen Special Economic Zone, and Minnan Delta. The product mix has shifted from a predominance of military products to civilian ones. The ratio between value of output of military and civilian goods has shifted from the pre-reform figures of 60:40 to 2:98. Before 1978, there were no color televisions, microcomputers, radios, calculators, video recorders, picture tubes, and so on. Today, they have become the dominant products of Fujian's electronics industry. The production capacity for televisions, radios, and calculators exceeds 1 million units in each case, and has reached 200,000 for microcomputers and 800,000 for black-and-white and color picture tubes. The production capacity for electronic components has increased more than 14-fold since 1978.

### II. The "Two Types of Opening Up" Have Promoted "Leaps" in Technical Progress

The electronics industry invested 150 million yuan and used \$36 million in foreign exchange during the Sixth 5-Year Plan to import 78 production lines and key equipment which enabled technical transformation of two-thirds of the enterprises in the industry. There now are 12 Chinese-foreign joint ventures and three wholly foreign-owned enterprises. In addition, various forms of horizontal technical and economic integration have developed, and the industry has built more than 20 enterprises via joint investments with concerned departments at various levels. Opening up to the outside and inside has promoted technical progress and growth in electronics enterprises.

Now, more than 60 percent of the enterprises have bid farewell to backward manual operations and achieved automated or semi-automated production. "Leaping" improvements have been made in technical levels of primary products. One product has received a silver award from the state, and 60 have received ministerial and provincial superior product awards. The value of industrial output in 1985 was 950 million yuan greater than in 1980, and taxes were up by more than 80 million yuan.

### III. Preliminary Results in Development and Application of Electronic Technologies

Over the past few years, the electronics industry in Fujian Province has adhered to the principle of "S&T orienting toward economic construction, economic construction depending on S&T" to carry out reforms in scientific research systems. They built five enterprise-type specialized technical research institutes and certain technical service companies which have reinforced the development, extension, and utilization of scientific research. Since 1979, they have developed 444 new products, more than 100 of which have received state, ministry, and provincial-level S&T achievement awards. In addition, applications of electronic technologies (mainly computer technologies) have been gratifying. According to incomplete statistics, Fujian Province now has over 2,000 microcomputers and more than 20 medium and small computers, including nearly 100 microcomputer applications scattered among the machinery, chemical industry, light industry, textiles, pharmaceutical, financial, posts and telecommunications, and other industries as well as in various administrative departments, and they are displaying obvious economic and social benefits every day.

### IV. Face International Markets, Become a "Bloodmaking Industry" Which Earns Foreign Exchange Via Exports

Export-oriented enterprises, increased exports, and participation in international competition have become part of the common consciousness of Fujian Province's electronics industry enterprises. Over the past 8 years, average yearly exports of Fujian electronics products have exceeded \$2 million and more than 20 types of products are being exported. They have expanded gradually from simple component exports to export of finished units and components. Predictions are that exports may reach \$20 million in 1987, which is 35 times the 1978 figure. The electronics industry has relied on its own vitality to become an important "bloodmaking industry" which earns foreign exchange.

As reforms and opening up continue to intensify, Fujian Province's electronics industry will solve problems that appear on the road to progress like the failure of managerial systems to adapt, inadequate construction capital and foreign exchange, shortages of technical personnel, a rather poor capacity for complete Chinese-made products, considerable difficulties in product exporting, and so on, and it will push forward to even more attractive shores.

12539/9738

## NEW RESEARCH PAVES WAY FOR BREAKTHROUGHS IN CONTROLLED FUSION

40080069a Beijing RENMIN RIBAO in Chinese 26 Dec 87 p 1

[Article by Yang Lianghua [2799 5328 0553]: "China Makes Breakthrough in Cyclotron Development"]

[Excerpts] With great significance to the economy and national defense, a new high-efficiency, high-power source for millimeter and sub-millimeter waves has been constructed by the Chinese Academy of Sciences. Systematic tests of the device, known as a cyclotron tube, shows that China has made a significant breakthrough in this technology. All major specifications are at the state-of-the-art level in the world.

A cyclotron tube is a laser-like new technology which began to emerge in the 1970's; the matter it excites, amplifies, and emits is not light, but electromagnetic waves in the millimeter and sub-millimeter range between microwave and visible light. Because of advantages such as high frequency, wide frequency spectrum range, good directional characteristics, concentrated energy, and resistance against atmospheric interference, millimeter and sub-millimeter waves can be used to develop state-of-the-art technologies including high-capacity communications, high-resolution detection, and directional energy transfer. The cyclotron has important applications in controlled nuclear fusion, large-volume secured satellite communications, high-precision missile guidance, and directed energy weapons.

After nearly 10 years of investigation technical personnel at the Institute of Electronics of the Chinese Academy of Sciences, including researcher Guo Hezhong [6753 0753 1813] and team leader Wu Deshun [0702 1795 7311], have invented a novel modular open-cavity cyclotron technology. The 8mm second harmonic cyclotron developed by them not only has high power output and efficiency, but also has a low magnetic field and is compact in size. A joint test with the Institute of Physics showed that the peak power of this cyclotron could reach 200 kilowatts at 30 percent efficiency. This is better than data known anywhere in the world. In addition, the Institute of Physics and Institute of Electronics have jointly developed a high-power millimeter-wave transmission system to successfully overcome one of the major obstacles in controlled nuclear fusion.

Experts believe that this breakthrough will play a significant role in the development of controlled fusion and in defense modernization in China.

12553/06662

'MAGIC LIGHT' LASER USED IN PLASMA EXPERIMENTS

40080068 Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 10 Feb 88 p 4

[Photograph and caption]



'Magic Light,' one of only a few high-power laser facilities in the world, was developed by the Shanghai Institute of Optics and Fine Mechanics (SIOFM) of the Chinese Academy of Sciences in 1987 and is now finding practical application. Shown is the device being used in a laser plasma interaction experiment at the Southwest Nuclear Physics and Chemistry Institute.

/23323



## SUPERCONDUCTING OXIDE CRYSTAL

40080072a Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 13 Feb 88 p 4

[Excerpt] Hefei, 12 Feb--After developing an oxide large single crystal last year, the Oxide Superconducting Material Joint Research Group of the China University of Science and Technology has produced six more, including a yttrium-barium-copper oxide single crystal with a length of 6mm, a width of 2mm, and a thickness of 1mm--larger than the single crystal developed by the Group last year.

Among the other superconducting oxide crystals are barium-copper oxide single crystals of the rare-earth elements ytterbium, dysprosium, holmium, erbium, and europium. As measured by direct-current resistance and alternating-current magnetic susceptibility, most of the systems' single-crystal zero-resistance temperature approached or exceeded an absolute temperature of 90°K.

06662

INVESTIGATION OF INTENSITY NOISE OF LASER DUE TO SIGNAL WAVE FEEDBACK IN FIBER-OPTIC GYROSCOPE

40090061a Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 15 No 2, 20 Feb 88 pp 80-84

[English abstract of article by Peng Gangding [1756 4854 1353], et al., of the Department of Electronic Engineering, Shanghai Jiaotong University]

[Text] The characteristics of laser intensity noise due to signal wave feedback in a fiber-optic gyroscope are investigated. It has been found that the signal wave feedback can cause a large amount of laser intensity noise and that an intensity noise peak appears at the signal detection frequency. By establishing a theoretical model for the laser in a fiber-optic gyroscope, the relationships of the intensity noise with various factors in the gyroscope are being analyzed, and the results are in good agreement with those of the experiment. Finally, the measures to reduce the effects of signal wave feedback on system performances are presented.

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MPI TECHNIQUE FOR KINETIC STUDY OF (NO + O<sub>3</sub>) REACTION

40090061b Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 15 No 2, 20 Feb 88 pp 85-88, 93

[English abstract of article by Shi Zhouzheng [2457 0719 2398], et al., of  
the Department of Physics, Fudan University, Shanghai]

[Text] The kinetics of a gas reaction by the multiphoton ionization method are reported. The detection of NO is made by the resonant multiphoton ionization of NO via the C<sup>2</sup>I<sup>1</sup> state. The rate constant of the NO reaction with O<sub>3</sub> is obtained as  $1.1 \times 10^{-14} \text{ cm}^3 \text{ mol}^{-1} \text{ s}^{-1}$  in a flow system, in good agreement with previous data. It is thought that the photodissociation of NO<sub>2</sub> will also contribute to the MPI signal at 365.45 nm. An apparent dissociation rate of about 50 percent at this wavelength has been obtained.

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RELAXATION IN TRANSIENT DEGENERATE FOUR-WAVE MIXING

40090061c Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 15 No 2, 20 Feb 88 pp 94-97

[English abstract of article by Lan Guang [5695 0342], et al., of Shanghai  
Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Text] A series of phenomenological relaxation equations has been introduced to describe the formation and decay of grating in the medium. The influences of medium relaxation on the transient properties of degenerate four-wave mixing have been studied theoretically and experimentally. Through investigation of the shape of the backward wave, the collection effect and smoothing effect have been observed. Theoretical explanations of the experimental results were perfect.

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STUDY OF 1kW TRANSVERSE FLOW CW HELIUM-FREE CO<sub>2</sub> LASER

40090061d Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese  
Vol 15 No 2, 20 Feb 88 pp 110-112

[English abstract of article by Qiu Junlin [8002 6511 2651], et al., of the  
Laser Institute, Huazhong Institute of Technology, Wuhan]

[Text] Experimental results are reported involving a 1kW transverse flow  
CW CO<sub>2</sub> laser in which helium has been replaced by argon. The main parameters  
are the same as those when using helium. Also given are the construction  
features of the laser, the factors causing temperature increases and the  
corresponding measures to be taken. The influence of argon on the upper  
energy level of CO<sub>2</sub> is analyzed.

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# CURRENT STATUS OF, FUTURE PLANS FOR QINSHAN NUCLEAR POWER PLANT

40080028 Chengdu HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING] in Chinese vol 8 No 5, 10 Oct 87 pp 25-27

[Article by Ou Yangyu (2962 7122 0056): "The Current Situation and Development at the Qinshan Nuclear Power Project"]

[Txt] [Abstract]--Construction of the 300 MW Qinshan Nuclear Power Plant now is fully underway. This article will outline project progress, equipment manufacture and design, safety analysis, preparations for debugging and operation, and other situations. It also will provide a brief introduction to long-term plans for the Qinshan project.

## I. Outline

The first concrete was poured for the main reactor building at the Qinshan project on 20 March 1985. Construction of the plant building has been progressing steadily for a little more than 2 years. Chinese-made equipment is being processed and manufactured in several plants and equipment imported from foreign countries is being received. Preparations for debugging and operation are being speeded up.

## II. The Construction Site

Work now is underway on most of the main production buildings. They include the reactor containment ("safety shell") building, reactor auxiliary systems building, fuel storage building, the building for the central power station control room, turbine generator building, and others. Work is almost complete on the cylinder of the containment building and the circular cranes are being installed. It has been predicted that the containment building can be completed before the end of 1987 and that pre-stressing to stretch the steel reinforcing mesh can begin in 1988. Then, the primary equipment and systems can be installed.

## III. Equipment Manufacture

The Shanghai Boiler Plant has finished manufacturing the stabilizer. Processing and manufacture are underway on two steam producers, and the

U-shaped piping imported from Sweden's Sandvik Plant has been shipped to the Shanghai Boiler Plant. The internal reactor components manufactured by the Shanghai No 1 Machine Tool Plant are 80 percent completed. Processing and manufacture are underway on the saturated steam turbines, which were jointly designed by the Shanghai Turbine Plant and Westinghouse Electric Company in the United States and manufactured by the Shanghai Turbine Plant, and on the turbo-generator with inner water-cooled stator and rotor designed and manufactured in China. Already at the site are the reactor pressure vessel manufactured by Japan's Mitsubishi Heavy Industries Ltd., the primary cycling pumps and circular cranes imported from the Federal Republic of Germany, and the main pipelines and reactor core neutron flux monitoring systems imported from France. Most of the other equipment (such as the pumps, valves, heat exchangers, ventilators, and other things associated with special safety systems, spent heat cooling systems, equipment cooling systems and so on) is being manufactured in China and processing now is underway. They will be completed during 1987 and 1988. The first load of uranium fuel of three different concentrations has been turned over to the fuel element manufacturing plant by the uranium enrichment plant for processing into fuel elements.

Re-examination of the design with a focus on safety is underway at the Shanghai Academy of Nuclear Engineering Research and Design. The accident at Chernobyl in the Soviet Union has raised popular concern about nuclear power plant safety to new heights. Over the past year or so, design safety analysis directed by the State Nuclear Safety Bureau has focused on design of the containment building, earthquake-resistant design, fire protection, prevention of flooding and moisture, terminal heat trap facilities, control and protection, and other areas, which have laid the foundation for a final safety analysis report. To strengthen safety monitoring in power plants, consideration is being given to the addition of slack component monitoring, safety parameter displays, accident sampling and testing, and other systems.

Inspection elements for fuel rods are being examined at a maximum fuel consumption of 27,000 MW.d/t (U) in the heavy water reactor at the Beijing Academy of Atomic Energy Sciences, and the results show that they conform to design requirements. The reactor core current distribution design and the internal configuration of the reactor have been revised on the basis of results of hydraulic simulation experiments with the reactor core. Control rod beam matching at operating temperatures and pressures, as well as rod-lowering experiments, have been completed, with satisfactory results.

In addition, with cooperation by the GRS Reactor Safety Institute in the Federal Republic of Germany, probability and safety evaluations are underway and proceeding smoothly at the Qinshan Nuclear Power Plant.



## V. Preparations for Startup and Operation

To inspect design and manufacturing quality and to assure safe operation, preparations for debugging, startup, and operation now are underway. Since 1985, groups of engineers have been sent to the Tsuruga Nuclear Power Plant in Japan, the (Ke'ersike) Nuclear Power Plant in Yugoslavia, and the (Buluokeduofu) [Bruchdorf?] Nuclear Power Plant in the Federal Republic of Germany for observation, practice, and training. The Shanghai Academy of Nuclear Engineering Research and Design has proposed a debugging program. On this basis, debugging and startup procedures and implementation details focused on the Qinshan Nuclear Power Company were formulated with assistance from the Shanghai Academy of Nuclear Engineering Research and Design. The main persons with on-duty responsibility for production will be sent for training at nuclear power plants in foreign countries and on simulators to permit them to obtain operating permits.

## VI. Primary Experiences

A great deal of experience and lessons have been gained after more than 2 years of practice in construction at the Qinshan project. The main things are:

1) Quality assurances are the central link in guaranteed safety. A complete quality assurance system must be established throughout the entire process of design, purchasing, manufacture, and construction and on to debugging, startup, and operation. Every person involved in this project must keep in mind the overriding importance of safety requirements. The Qinshan Nuclear Power Company has compiled a quality assurance program for the entire project which has been approved by the State Nuclear Safety Bureau. Quality assurance systems and quality inspection systems now are taking shape in all of the design units, manufacturing plants, and construction and installation companies. Item management is being reinforced to assure that every problem during design, purchasing, manufacture, construction, debugging, and operation is dealt with and that there are no mistakes.

2) We must conscientiously absorb and digest current international nuclear power plant regulations, standards, and guiding principles, and they must be applied in conjunction with real conditions in China. China's own nuclear power plant regulations, laws, and standards will be formulated as soon as possible on this foundation. Currently, the State Nuclear Safety Bureau is using IAEA regulations as the basis for some laws and guiding principles. A substantial portion of ASME, ASTM, and IEEE regulations, Federal Regulation 10CFR, NRC management principles and NUREG were adopted for the design of the Qinshan project. Some of China's own scientific research experiments and technical experience have been absorbed into technical requirements.

3) We must continually re-examine designs and propose and resolve topics in safety analysis until we complete a final safety analysis report. It is particularly important that attention be given to finding suitable solutions

to all types of interfacing questions, such as interfaces among the designs for each portion, between equipment and systems, and between systems and systems. Everything must be coordinated to assure that there are absolutely no mistakes throughout the project.

The principles employed during construction of the Qinshan project are "safety first, quality first." Any deviation from these principles must be corrected immediately.

## VII. Significance of Qinshan Project

Qinshan No 1 is a prototype demonstration pressurized water reactor. Although it will produce only 300 MW of electric power, it will have the same technical characteristics as large nuclear power plants. By building this nuclear power plant, we will gain first-hand experience and accumulate valuable technical data in a systematic fashion, all the way from research and design to completion and operation, and several nuclear power plant personnel will be trained. We are confident that construction of this nuclear power plant will smooth the road for development of the nuclear industry in China.

Actual conditions in China make construction of medium- and small-scale nuclear power plants appropriate because:

- 1) They are better adapted to the capacity of China's power grids, since most of China's power grids do not have a very large capacity.
- 2) Total investments are smaller and capital is easier to raise.
- 3) Equipment and components are smaller, quality is easier to guarantee, and China is able to manufacture a larger proportion of them.
- 4) Construction schedules are shorter, which permits early recovery of capital and provides power to reduce power shortages more quickly.

## VIII. Prospects for Development

Given these reasons, China decided in 1986 that for a substantial period into the future, the focus will be on construction of nuclear power plants with a single-unit generating capacity of 600 MW. These medium- and small-scale generating units are more adapted to standardized and systematized manufacture.

Qinshan is a very good site for a nuclear power plant, and there is sufficient room here to install four 600 MW generating units. Construction will be divided into two periods, each of them involving construction of two 600 MW generating units. Construction of new generating units will require absorption of successful experiences with 300 MW generators, and it also will require that mature foreign technologies be absorbed to integrate the two well, produce better commercial results from the 600 MW generating units, and turn them into commercial power plants as quickly as possible.

Feasibility research for the second stage of the Qinshan project began in July 1986 and is developing. At the same time, on-site terrain surveying and geological exploration are being supplemented to meet the requirements for 600 MW generating units.

STUDY OF ANGULAR DISTRIBUTION FOR  $^{59}\text{Co}(\alpha, p)$  PREEQUILIBRIUM EMISSION AT 26 MeV

40090056a Beijing YUANZHE WULI [CHINESE JOURNAL OF NUCLEAR PHYSICS] in Chinese  
Vol 9 No 4, Nov 87 pp 289-298

[English abstract of article by Xu Jun [1776 0193], et al., of the Institute of Atomic Energy, Beijing]

[Text] Angular distributions and energy spectra for  $^{59}\text{Co}(\alpha, p)$  preequilibrium and equilibrium emissions at 25.9 MeV incident energy are measured. The experimental data are analyzed using the Generalized Master Equation Exciton Model, taking into consideration differences between the emissions of fast and slow particles. The study shows that it is necessary to distinguish the emitted directions and emitted rates of the fast and slow particles for analyzing the angular distribution of preequilibrium and equilibrium emission.

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ELASTIC, INELASTIC SCATTERING OF ALPHA PARTICLES ON  $^{56}\text{Fe}$  TARGET AT 26 MeV,  
COUPLED CHANNEL ANALYSIS

40090056b Beijing YUANZHE WULI [CHINESE JOURNAL OF NUCLEAR PHYSICS] in Chinese  
Vol 9 No 4, Nov 87 pp 299-306

[English abstract of article by Lou Yunian (1236 1342 1628), et al., of the  
Institute of Atomic Energy, Beijing]

[Text] Elastic and inelastic scattering of alpha particles on a  $^{56}\text{Fe}$  target are measured at incident energy of 26 MeV. The angular distribution of elastic scattering is studied using the optical model. The deep well potential and shallow well potential optical parameters are obtained, and both fit the experimental results well. By using DWBA and the Coupled Channel Theory, different cases of angular distribution of elastic and inelastic scattering are analyzed (two channels coupled, three and four channels coupled, with deep and shallow well potentials, respectively). It is shown that only the shallow well potential parameters fit the experimental data well. The deformation parameters of some states are deduced.

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STUDY OF THERMAL NEUTRON CAPTURE IN  $^{23}\text{Na}$

40090056c Beijing YUANZIHE WULI [CHINESE JOURNAL OF NUCLEAR PHYSICS] in Chinese Vol 9 No 4, Nov 87 pp 307-315

[English abstract of article by Zhang Ming [1728 2494], et al., of the Institute of Atomic Energy, Beijing]

[Text] Energies and intensities of 117 gamma-rays produced by the capture of thermal neutrons in  $^{23}\text{Na}$  are measured using a single Ge(Li) detector and a paired spectrometer. Placed in the decay scheme, consisting of 35 levels, are 107 gamma-rays. The neutron binding energy is found to be 6959.51 (21) keV. The  $^{23}\text{Na}$  energy level density parameters are determined with the Backshift Fermi Gas Model. The  $^{23}\text{Na}(n,\gamma)^{24}\text{Na}$  reaction is mainly a statistical process from the resonance capture of the 2.85 keV state.

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$K^+p$  INTERACTION STUDY IN QUARK MODEL

40090056d Beijing YUANZIHE WULI [CHINESE JOURNAL OF NUCLEAR PHYSICS] in Chinese Vol 9 No 4, Nov 87 pp 321-328

[English abstract of article by Teng Lijian [3326 4409 1017] of Sichuan University, Chengdu; Zhao Xuan [6392 3763], et al., of the Institute of Nuclear Research, Chinese Academy of Sciences, Shanghai; Wang Fan [3769 0416] of Nanjing University]

[Text] The S-, P-, D- and F-wave phase shifts and the differential elastic cross sections of the  $K^+p$  system are calculated in the framework of a non-relativistic quark model (QM), using RGM and the QCD one-gluon exchange qq interaction. The effect of each term of the qq interaction on the  $K^+p$  interaction is obtained by analyzing the phase shifts calculated from the corresponding term, and it is shown that the odd-even l-dependence and J-dependence of the  $K^+p$  phase shifts may result mainly from the quark exchange effects of the various terms of the qq interaction. The agreement between the theoretical and experimental phase shifts and cross sections are reasonably good, indicating that the QCD qq residual interaction can reproduce effective  $K^+p$  interaction to some extent.

9717

STUDY OF SOME CHARACTERISTICS FOR REACTOR FILTERED BEAMS

40090056e Beijing YUANZIHE WULI [CHINESE JOURNAL OF NUCLEAR PHYSICS] in Chinese Vol 9 No 4, Nov 87 pp 360-366

[English abstract of article by Chen Changmao [7115 1603 5399], et al., of the Institute of Atomic Energy, Beijing]

[Text] Quasi-monoenergetic neutron beams of 186 keV, 24.4 keV and 144 keV have been obtained at the tangential channel of a swimming pool reactor by using  $^{238}\text{U}$ ,  $^{56}\text{Fe}$  and  $^{28}\text{Si}$  filters, respectively. Some characteristics, such as beam purity and neutron fluence rate on the axis direction, have been determined. The results show that the beam purity is nearly independent of the axial distance, the fluence rate decreases as the distance increases and the trend of the fluence rate attenuation approximately follows the inverse square law of a point source. The position of the equivalent point source is far from the reactor core. The conclusion reached to explain the phenomenon is that the purity of the 24.4 keV neutron beam varies with the Fe filter position as observed by Kondaiah, et al.

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MICROSTRUCTURAL CHANGES OF Ni INDUCED BY  $\text{Ag}^+$ ,  $\text{Bi}^+$  ION BOMBARDMENT

40090056f Beijing YUANZIHE WULI [CHINESE JOURNAL OF NUCLEAR PHYSICS] in Chinese  
Vol 9 No 4, Nov 87 pp 367-372, 379

[English abstract of article by Wang Peixuan [3769 0160 3872] of Beijing  
University of Iron and Steel Technology]

[Text] Thin (25-60 nm) Ni films have been implanted with 40-130 keV  $\text{Ag}^+$  and 100-200 keV  $\text{Bi}^+$ , and investigated using RBS and TEM. In fine-grain thin films, the implantation induces significant recrystallization and grain growth for doses of  $\phi \geq 10^{15} \text{ cm}^{-2}$ . The average grain diameter increases with the dose, and the growth rate is linearly proportional to the energy deposited into the elastic collision,  $E \cdot v(E)$ , while it also depends on the film thickness. For high  $\phi$ , the Ni films exhibit the  $\langle 110 \rangle$  preferred orientation, and a typical plate fiber texture has been identified. Ni films evaporated on 673K substrates show numerous extended defects without forming microtwins, which are typical in bombarded fine-grain films. The high density of defects and the high strain energy produced by ion bombardment, along with the tendency to reduce the surface energy at the very large grain boundary and free surface area, are thought to be the driving forces. Ni atoms activated by energy spikes accomplish short-range movement during relaxation, resulting in recrystallization and grain growth.

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NUMERICAL CALCULATION USED IN THICK TARGET PIXE ANALYSES

40090060a Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS] in Chinese Vol 12 No 1, Jan 88 pp 6-11

[English abstract of article by Fan Qinmin [5400 2953 2404], et al., of the Institute of High Energy Physics, Chinese Academy of Sciences]

[Text] Numerical calculations were used to correct the measured K X-ray intensities in thick target PIXE analyses for the following matrix effects: slowing of protons, absorption of characteristic X-ray, and X-ray induced X-ray emission in the sample. The efficiency calibrations for the PIXE analysis system were made using the Monte Carlo technique. Based on these corrections and calibrations, the PIXE analysis results involving some of our thick specimens were obtained without the use of the standard method, obtaining good agreement between the measured and known values of contents.

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INTELLIGENT ENVIRONMENTAL NEUTRON, GAMMA MONITORING SYSTEM

40090060b Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS] in Chinese Vol 12 No 1, Jan 88 pp 12-18

[English abstract of article by Li Jianping [2621 1696 1627], et al., of the Institute of High Energy Physics, Chinese Academy of Sciences]

[Text] In this paper, the construction and performance of an intelligent environmental neutron and gamma monitoring system are described. The neutron monitor has high sensitivity, light weight and a small size. A charge pump circuit is adopted for the I-F converter of the gamma monitor. The local data acquirer consists of a CMOS single-piece processor with high speed and low power dissipation. A FLEX microcomputer is used as a remote center computer for data handling and graph plotting. The system has been operating continuously for more than one year with high stability and reliability.

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NUCLEAR CHARGE DISPERSION OF FRAGMENTS IN HIGH ENERGY PROTON-NUCLEUS COLLISION

40090060c Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS] in Chinese Vol 12 No 1, Jan 88 pp 75-79

[English abstract of article by Lu Zhaoqi [4151 0340 0796], et al., of the Chinese Institute of Atomic Energy, Beijing; D.H.E. Gross of Hahn-Meissner-Institute, Berlin, West Germany]

[Text] The charge dispersion of fragments in high energy  $p + \text{Cu}$ ,  $\text{Kr}$  and  $\text{Xe}$  reactions are calculated using a statistical model and the Monte Carlo technique. The corresponding data are reproduced quite well. It is shown that the charge dispersions are all nearly gaussian. The mass dependence of the most probable fragment charge reflects the resting target memory effect.

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MASS DRIFT FLUCTUATION, SHELL EFFECT IN HEAVY ION COLLISIONS

40090060d Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS] in Chinese Vol 12 No 1, Jan 88 pp 109-115

[English abstract of article by Li Junqing [2621 0689 3237], et al., of the Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou; Zhu Jieding [2612 0094 7844] of the Department of Modern Physics, Lanzhou University]

[Text] A master equation is solved numerically for the mass drift and fluctuation of three reactions. The driven potential is calculated by means of D. Myers' mass formula pluss a shell correction. The results indicate that the lack of mass drift in the range of zero to a considerable energy loss in heavy ion collisions can be explained by the transport theory. Due to the small mass mobility coefficient, the mass does not drift much during a short time interval. The effect of the shell structure in the driven potential is obvious for mass relaxation in the low energy loss region.

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## DEVELOPMENTS IN FIBER-OPTIC COMMUNICATIONS REPORTED

### New Terminal for Fiber-optic Communications

Beijing ZHONGGUO DIANZI BAO in Chinese 4 Dec 87 p 3

[Article by Yu Ruming [0151 3067 2494] and Zhang Hongsen [1728 3163 2773]]

[Text] The Model GD34-02 terminal for fiber-optic communication, developed jointly by the Chongqing Communication Equipment Plant of the Ministry of Posts and Telecommunications (MPT) and the 44th Institute of the Ministry of Electronics Industry, passed product review on 22 October.

The Model GD34-02 terminal is a piece of key equipment in tertiary-group fiber-optic communication. The machine is coded by the 3B/4B circuit and runs in the operating, warm standby and cold standby mode. It includes features such as delayed and real-time alarm. For the first time, it uses the international standard 120-mm narrow frame. Its transmission rate is 34.368 Mbps +/- 20ppm. The circuit code is scramble code + 3B/4B. The optical reception sensitivity is better than -48 dBm (when  $p_e = 1 \times 10^{-9}$ ). The tolerance to vibration is higher than that specified by the International Telegraph and Telephone Advisory Committee.

The unit has a modern design and operates reliably. It is structured with standardization, serialization and practicality in mind. The major specifications can meet the requirements set by MPT for a terminal to enter a network. It has been used for nearly a year in a 6-km tertiary-group digital fiber-optic communication system in Chongqing with good results.

### New Fiber-optic Production Line at Huainan

Beijing ZHONGGUO DIANZI BAO in Chinese 6 Dec 87 p 1

[Article by Jin Congan [6855 1783 1344]]

[Text] Huainan Fiber-optic Communication Corporation, a joint venture between the Eighth Institute of the Ministry of Electronics Industry and Huainan Electronics Corporation, successfully imported a single-mode optical-fiber production line from the SG Company in England. With the support of relevant departments, construction, equipment import, personnel training, installation and debugging were done within a year. Trial run was successful.

Recently, experts who visited the plant unanimously agreed that the production capacity and major specifications of the product have reached or exceeded those stated in the contract. The sediment materials are all made domestically. Product specifications can meet the requirements for shallow ocean cable and regional communication system applications. Indicators such as fiber screening tension and product yield are among the leaders in China.

It is rare to see the kind of fast absorption and application of imported technology demonstrated by the Huainan Fiber-optic Communication Corporation. This is a result of combining an institution with a plant to integrate the strength of research and production. A production line with an annual capacity of 6000 km of optical fiber is essentially completed. On the basis of producing high-strength and long-length fiber with consistency, applications of fiber-optic communication technology will be actively developed and expanded. These applications will stimulate production and open up new markets that will provide greater economic returns.

#### Changsha-Xiangtan Fiber-optic Communication Network

Beijing RENMIN RIBAO (overseas edition) in Chinese 18 Dec 87 p 1

[Text] The Changsha-Xiangtan fiber-optic communication network, jointly built by the Hunan Province Department of Posts and Telecommunications and Plessey Telephone Company of England, is now in operation. This is the first instance of the use of single-mode optical cable over 50 km without a relay station. The capacity of the long-distance fiber-optic communication system is 140 Mbps, and the range is 50 km. There are 1920 circuits. In the first stage, 180 automatic and semi-automatic lines are made available. Upon completion, 480 automatic and semi-automatic lines will be available. The remaining lines are dedicated to the digital microwave communication between Changsha and Zhuzhou to create a Changsha-Xiangtan-Zhuzhou network.

#### First 24-Core Fiber-optic Cable Developed

Beijing ZHONGGUO DIANZI BAO in Chinese 27 Dec 87 p 1

[Article by Wei Baozhi [7614 0202 5347]]

[Text] The Eighth Institute of the Ministry of Electronics Industry recently developed the first 24-core composite optical cable. In addition, a 6-km length of the high-performance product was supplied based on customer requirement.

This cable is made of four 6-core optical cables and two 4-core electrical cables. The protective jacket of the optical cable is made of aluminized polyethylene. The outer layer is a plastic jacket. In order to improve water resistance and pressure resistance, a 6-slot reinforcing frame is used. The core is completely back-filled.



The successful development of this cable signifies an advance in China's capability to manufacture multi-core optical fibers.

Beijing Forming Fiber-optic Communications Industry

Beijing RENMIN RIBAO (overseas edition) in Chinese 31 Dec 87 p 3

[Article by Huang Wei [7806 1218] of the Xinhua News Agency]

[Text] It is understood from the newly established Beijing Fiber-optic Communications Society that a fiber-optic industry is shaping up in Beijing. This technology will be widely used in telephone, electric power, transportation, public safety, radio, television and data transmission.

Fiber-optic communications is a new technology. It has such advantages as wide bandwidth, high capacity, low loss and tight security. In China, a fiber-optic communication industry has already been set up in Wuhan, Tainjin, Shanghai and Xian. The technology is advancing very rapidly in Beijing recently. The area has over 30 organizations engaged in research, development and production in fiber-optic communications. It has definite advantage in talent and technology in areas such as system design, testing instrumentation, terminal equipment, and source and sourceless devices.

Forty-eight organizations in the Beijing area involved in research, development, production and application of fiber-optic communications have now formed an association.

11442/9738

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NEW PRECISION IN SATELLITE GROUND-STATION ANTENNA ALIGNMENT

40080058a Beijing ZHONGGUO DIANZI BAO in Chinese 4 Dec 87 p 3

[Article by Shen Hong [3088 1347]: "New Satellite Ground-Station Antenna Alignment Technology"]

[Text] The precision axial antenna-alignment technique for satellite television receive-only (TVRO) stations developed by the Changzheng [Long March] Machinery Plant of the Ministry of Astronautics is a radical change from the outdated method of using a screen-image fix to adjust the antenna's azimuth. It ensures that the signal received is at its optimal intensity. The Ministry of Astronautics awarded this accomplishment with a 3d-class science and technology award in 1987.

The new technology is based on the estimation of the angle between axial direction of the antenna and the satellite. It was successfully developed by improving the internal circuitry of the TVRO station's video receiver and by increasing the number of digital displays. It is a thousand times more accurate in capturing satellite signals than relying on the receiver instruments of the LED indicator. In particular, it is continuously tunable to capture any discrete frequency signal in C band between 3.7 and 4.2 GHz. Moreover, that frequency's field strength data is displayed to an accuracy of  $\pm 0.005$  mV. This accuracy can be further improved by using a different digital display.

This technology has been installed in over 320 satellite TVRO ground stations in China and has been well received by these stations.

12553/06662

## NEW SCANNING TUNNEL MICROSCOPE DEVELOPED

40080058b Beijing RENMIN RIBAO in Chinese 22 Dec 87 p 1

[Article by Zhuo Peirong [0587 1014 2837] as a wire report of the Xinhua News Agency dated 21 Dec 87: "New Scanning Tunnel Microscope Developed, Atomic Resolution and State-of-the-Art Quality"]

[Text] A new generation of scanning tunnel microscope has been successfully designed and developed jointly by two institutions in the Chinese Academy of Sciences: the Beijing Electron Microscope Laboratory and the Institute of Chemistry. Recently, the resolution of this microscope has reached the atomic level. It can be used to observe the highly orderly oriented atomic array on the surface of graphite. The quality of the picture is also at an international state-of-the-art level. As scientists introduced this accomplishment to reporters the other day, it was pointed out that this microscope provides the necessary basis for Chinese scientists to pursue a wide range of studies in scanning tunnel microscopy to unveil the secrets in the microscopic world.

This new microscope was first introduced in 1982. It is based on the quantum mechanical tunnelling effect. A sample in the shape of a pin tip of very small diameter is scanned to obtain its surface morphology in order to see the atomic structure and arrangement. It has a very bright future in microelectronics and other fields.

The development work, which began last winter, was done by a group of people led by researcher Yao Junen [1202 0193 1869] of the Beijing Electron Microscope Laboratory. Assembly and testing began last summer. The work was supported by the famous scientist Guo Kexin [6753 0668 0207]. A young scientist, Bai Chunli [4101 2504 4409], from the Institute of Chemistry was engaged in the same field in the United States. After he found out that this project was underway in China, he declined an offer to work for a company in the United States and returned to China to contribute his talent to the development of this instrument. The State Planning Commission and State Science and Technology Commission provided a great deal of support to this project.

12553/06662

## PROTOTYPE SATELLITE GROUND-STATION INTERMEDIATE-FREQUENCY SYSTEM EVALUATED

40080058c Beijing ZHONGGUO DIANZI BAO in Chinese 29 Dec 87 p 3

[Article by Zhang Liangye [1728 6647 6460]: "Research Prototype Satellite Ground-Station Intermediate-Frequency System Evaluated"]

[Text] A research prototype satellite ground-station intermediate-frequency (IF) system for digital multiplexed communications has been evaluated.

The comments of the group of experts include the following: this IF system for digital satellite communications (including error-correction, code-scrambling, and QPSK [quaternary phase shift keying] modem units, developed by Qinghua University with assistance from Zhenhua [2182 5478] Corporation, resolves several major technical issues--such as maximization of gain, decoding of convolutional codes with simple equipment, frequency spectrum formation, and modulation and demodulation of band-limited QPSK signals--with modern technology. The results of the test done with the prototype showed that all major specifications (usable bandwidth, radiation leakage outside the bandwidth, carrier pull-in range, code error and code scrambling, and digital interface) have comfortably met the requirements specified in the plan. Certain characteristics (such as usable bandwidth, framework for the modulated spectrum, code scrambling, and digital interface) have met ITU standards published by Intelsat Corporation in 1987. The university has done some preliminary testing on reliability and stability.

The factory is yet to carry the testing further. This is China's first successful development of a practical prototype digital satellite-communications IF system of such superior frequency-spectrum efficiency and power efficiency. This accomplishment is a significant contribution to the development of digital multiplexing and its future applications. Let us transfer it to the factory to build production prototypes.

12533/06662

## DUAL-CHANNEL DYNAMIC DIGITAL IMAGE PROCESSOR DEVELOPED

40080058d Beijing ZHONGGUO DIANZI BAO in Chinese 29 Dec 87 p 3

[Article by Yang Yuqiu (2799 3768 4428): "A Dynamic Dual-Channel Digital Image Processing Device"]

[Text] Several teachers at Harbin Institute of Shipping Engineering including Yi Jixia (2496 4949 7209), Zhang Jidong (1728 4480 2639), Kong Yixing (1313 0001 2502) and Wei Hongji (7614 7703 1015) successfully developed a dual-channel dynamic digital image processing device and it has passed a technical evaluation.

This device is a key component in the multiple-brightness electronic scoreboard multi-microcomputer network system being developed at the Shandong Athletics Center. It has two image processing systems for simultaneous dynamic and static information processing. Image input and output is real time. Both channels not only can handle input and output simultaneously but also can switchover at any time. Window operations are allowed on the system output image, either on the dynamic or static image. The size and location of the window can be set by the computer and can change continuously. The maximum number of windows is four. The two images can be synthesized and superimposed. Through a computer, characters can also be added to the image on the screen. The device also employs certain key technology such as storage buffer, read/write time sharing, and controlled synthesis to perform real-time dynamic processing of video signals and image synthesis processing. Furthermore, it has freeze-frame capability.

Experts believe that the device's digital circuitry achieves certain special functions possessed by some imported special signal generators. Its technological complexity is high, and it is the first such equipment in China.

12553/06662

## FIRST CHINESE-MADE SATELLITE REMOTE-SENSOR PROCESSING SYSTEM

40080058e Beijing GUANGMING RIBAO in Chinese 12 Jan 88 p 2

[Article by Xia Xin [1115 2946]: "First Chinese-made Satellite Remote-Sensor Processing System Introduced, Clearing Blurred Raw Satellite Cloud Pictures"]

[Text] A blurred original satellite picture of the cloud cover can become very bright and clear by the instantaneous processing of a microcomputer. The color and brightness in every local area may be a reliable source of information for weather forecasting and for monitoring events such as fires and forest disease. This satellite remote-sensor processing system is based on a Changcheng (Great Wall) 0520 microcomputer. It was recently evaluated in Nei Monggol and was installed at the Nei Monggol Weather Station. Specialists consider this system to have reached the leading edge in international technology.

The development of such a complicated weather satellite remote-sensor processing system on a microcomputer was completed in the short space of 1 year by Professor Cai Xuexun [5591 1331 8113] of Beijing Posts and Telecommunications Institute, a middle-aged teacher, and three recently graduated graduate students.

Prior to this installation, only the central weather station, among dozens of weather stations in China, had this type of equipment. That piece of equipment was imported at a cost of more than a million U.S. dollars. In view of this situation, in 1980 Professor Cai chose to develop a satellite remote-sensor processing system on a microcomputer. Over the years, the system was developed successfully on TRS-80 I and BCM-II computers. These achievements received first-class technical awards from the Ministry of Posts and Telecommunications and from the city of Beijing, respectively. Beginning in November 1980, Professor Cai led a team of five to develop the system for a Changcheng 0520CH machine. In such an involved engineering project, the work was divided and distributed. For over a year, everyone worked long hours almost daily. Some of them slept in the laboratory. Professor Cai, the leader of the charge, travelled back and forth between Beijing and Nei Monggol even while he was sick. It was this kind of spirit that ensured the completion of the project. The new product has a full range of functions. It is a high-quality, low-cost product. It only costs approximately 200,000 yuan.

12553/06662

## DEVELOPMENT OF AIR CUSHION VEHICLE DETAILED

40080067 Beijing JIANCHUAN ZHISHI [NAVAL AND MERCHANT SHIPS] in Chinese No 12,  
8 Dec 87 p 6

[Article by He Qun [7729 5028]: "China Builds Its First Air Cushion Vehicle"]

[Text] The first Chinese-designed and built air cushion vehicle--the 7301 self-propelled air cushion vehicle--was recently successfully tested at Hangzhou. It was designed by the 708th Institute of the China Navigation Company for the Danggang oil field and built by the Dongfeng Shipyard in Hangzhou.

In recent years other countries have developed air cushion vehicles for developing off-shore oil fields for transporting equipment used for off-shore and coastal oil exploration and for supplying tools. Japan, Canada, the USSR, the U.S., and England have each developed various types of air cushion vehicles. The USSR in particular has built a great number of these vehicles for the development of its northern regions to solve communications and transport problems there.

The air cushion vehicle utilizes main engines to drive lift fans which provide air beneath the vessel so that the air cushion can float on the water surface. Flexible skirts around the sides are used to maintain the air cushion.

In principle, the air cushion vehicle is similar to the full pad hovercraft, but there are many differences. First of all, the air cushion vehicle's air pressure is greater, generally 5-6 times that of the hovercraft. Second, the skirt height is lower than that of the hovercraft, usually not exceeding one-eighth of the beam to ensure that the air cushion vehicle has sufficient stability. Third, structurally, the air cushion vehicle is made mostly of steel and can carry heavy equipment and extra-large loads.

Air cushion vehicles may be divided into two categories depending on the means of propulsion: the self-propelled air cushion vehicles and the driven air vehicles.

The self-propelled type has its own propulsion system. Propulsion equipment is installed on the vehicle; some have ducted propellers, some also use paddle or screw propellers, rubber wheels, and crawler drive wheels. The self-propelled type's load is carried by the air cushion while the propulsion equipment type provides the drive power and either does not bear or bears very



little of the load. The self-propelled air cushion vehicle is flexible and is not limited by surface or topography, but since the propulsion equipment takes up a certain amount of the deck area, the effective load is somewhat less.

Driven air cushion vehicles do not have propulsion systems and cannot be self-propelled but must rely on other propulsion. On water they rely on towing by tugboats but on land they must be pulled by tractors.

The 7301 self-propelled air cushion vehicle maximum load is 35 tons. The main body, i.e., the hull, is of welded steel while the superstructure is made of aluminum alloy. The platform is 19.2 m long, 12.2 m wide, and 6.9 m high.

The bottom of the vehicle is surrounded by a skirt made of rubberized fabric 1 meter high. The air cushion pressure is  $500 \text{ kg/m}^2$ . The drive equipment uses two V-12 Model 180 high-speed diesel engines which drive the air cushion lift fans and the ducted propellers. The diesel engine is small in size, lightweight, weighs 1.4 tons, is rated at 800 hp, is compact in structure, has advanced economic indicators, good control performance, and is reliable and easy to use. At low-speed propulsion efficiency is high. It has smaller diameter and lower noise than ordinary air propellers. At the same time, the ducts serve as covers for the vanes so that they are not easily damaged.

The air propellers and the cushion lift fan on the 7301 air cushion vehicle are linked so that the shaft system is simple and compact. The cushion lift fan is a centrifugal fan, the circular speed is high and the diameter is 1.4 m.

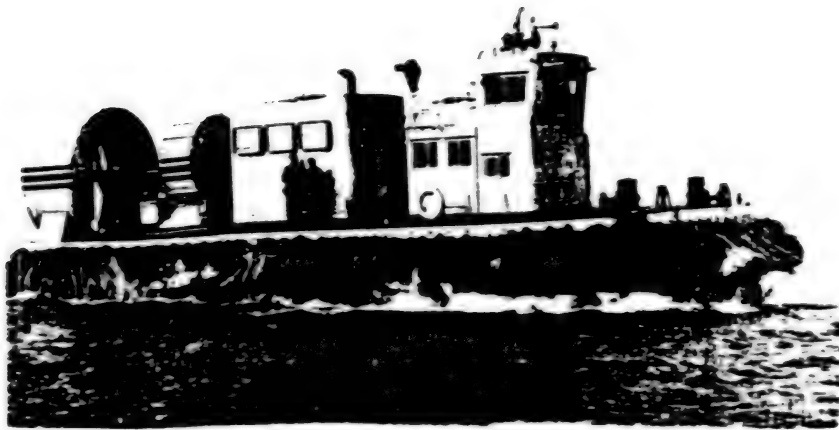
Load-regulating water chambers are located at the four corners of the air cushion vehicle and when under way they are used to regulate the vehicle's attitude. Because the actual operation of the air cushion vehicle is complex, there is no loading-unloading equipment, especially since the vehicle is rather sensitive to topographical slope, the propellers alone cannot meet the demands of climbing a slope. For this reason, two harmonic drive capstans are installed on the vehicle's bow. The towing force of each capstan is 2.5 tons.

The displacement of the 7301 air cushion vehicle when fully loaded is 80 tons, speed in calm water is 5-20 km/hr, and maximum speed is 20 km/hr. Endurance time is 6 hours.

The 7301 air cushion vehicle can be used in tidal areas where the water depth is 0-2 m and can also be used in marshy areas with surface load ability of less than  $0.1 \text{ kg/cm}^2$ .

After this air cushion vehicle was developed, a technical evaluation meeting was jointly convened by the Dagang Petroleum Management Bureau of the Ministry of Petroleum Industry, the 708th Institute of the China Navigation Company and the Zhejiang Province Shipping Industry Company. After evaluation by the representatives at the meeting, it was generally felt that the performance indicators of this vehicle were basically rational and after land and sea tests, the primary functions met the demands of the design specifications, its development was successful and it will add new equipment for oil field development and open new routes for the application of air cushion technology.





8226/12913

## NARROW WAVE BEAM-TYPE GRAVITATIONAL RADIATION OF SPACE ARRAYS

40090057a Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 36 No 12, Dec 87 pp 1570-1582

[English abstract of article by Li Fangyu [2621 5364 2509] of the Department of Applied Physics, Chongqing University; Tang Mengxi [0781 1322 1585] of the Department of Physics, Zhongshan University, Guangzhou]

[Text] This paper briefly describes gravitational radiant power and the radiant angle distribution of space rectangular lattice arrays of mass quadrupole oscillators, and presents the analytical expressions involved. The calculations show that these arrays can generate narrow gravitational radiation wave beams with the best directional properties. The traveling wave-type gravitational radiation theory, developed by Seki, et al., may be regarded as a specific case of the work in this paper and can be derived. Under the conditions of ideal ultrahigh frequency acoustic resonance and perfect traveling wave-type synchronism intensification, a numerical example calculated using the authors' method shows that the energy flux density of gravitational radiation of the optimal direction of a space array, consisting of 100 CaS crystals of  $30 \times 30 \times 0.03 \text{ cm}^3$ , would reach  $2.84 \times 10^{-1} \text{ erg/cm}^2 \cdot \text{s}$ . These results show the potential of crystal space arrays exciting high-frequency gravitational radiation.

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THEORY OF SUPERCONDUCTIVITY IN  $\text{CeCu}_2\text{Si}_2$ ,  $\text{UBe}_{13}$ . I. MODEL,  $T_c$ , ORDER PARAMETERS

40090057b Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 36 No 12,  
Dec 87 pp 1590-1597

[English abstract of article by Xu Jihai [1776 4949 3189] of the Department of  
Physics, Shandong University, Jinan]

[Text] The heavy-fermion superconductivity (HFS) phenomena of  $\text{CeCu}_2\text{Si}_2$  and  $\text{UBe}_{13}$  have been investigated theoretically, starting with the periodic Anderson lattice model and taking into consideration the interaction between the localized electrons and the localized lattice deformation. Through the calculations, the author obtained a reasonable superconducting transition temperature,  $T_c$ , and showed that the parameter describing the isotopic effect,  $\alpha < 1/2$ , could even equal zero (in BCS theory,  $\alpha = 1/2$ ). The author showed that the isotopic effect is smaller in this theory than in BCS theory, with the present theory even allowing the possibility of no isotopic effect existing in the model. The results are in agreement with the experimental HFS facts. In addition, the curves of the order parameters, varying with temperature and density of state, are given, reaching the conclusion that f-electrons are responsible for HFS.

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## NEUTRON DIFFRACTION STUDY OF Mn-Zn FERRITE CONTAINING TITANIUM

40090057c Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 36 No 12, Dec 87 pp 1610-1613

[English abstract of article by Yang Jilian [2799 4949 1670], et al., of the Institute of Atomic Energy, Beijing; Yu Mei [0151 2734], et al., of the Department of Physics, Beijing University]

[Text] Mn-Zn ferrite has been used extensively in a variety of communications. The frequency range is from several hundred kHz to several MHz. However, in the range of  $-40 - 80^{\circ}\text{C}$ , the temperature coefficient of the permeability of pure Mn-Zn ferrite is rather high, making the working frequency drift a little. This causes some problems during use. In order to improve the  $\mu(T)$  curve, a variety of elements have been added to the Mn-Zn ferrite. It has been found that the  $\mu(T)$  curve can be improved efficiently by adding only a small amount of titanium to the Mn-Zn ferrite. In order to understand the effect of titanium in the material, neutron diffraction structural analysis of the Mn-Zn ferrite containing titanium was carried out. The experimental results show that the Ti atom occupies the B site, while Mn and Zn preferentially occupy the A site. In addition, the magnetic moment per molecule was also measured. The results are discussed preliminarily.

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DETERMINATION OF SUPERCONDUCTING ENERGY GAP OF HEAVILY DOPED Re THIN FILMS  
BY ELECTRON TUNNELING

40090057d Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 36 No 12,  
Dec 87 pp 1643-1644

[English abstract of article by Wang Ruilan [3769 3843 5695], et al., of the  
Institute of Physics, Chinese Academy of Sciences]

[Text] The superconducting energy gap of heavily-doped Re thin films has  
been measured by electron tunneling of Re/Al<sub>2</sub>O<sub>3</sub>/Al junctions. The authors  
obtain  $\Delta_0 = (1.04 \pm 0.02)$  meV,  $2\Delta_0/KT_C = 3.31 \pm 0.04$ . The  $\Delta_0$  value is deter-  
mined by the maximum conductance method. It is shown that the energy gap  
and the  $T_C$  of Re films increases many times with impurities, but Re remains  
a weakly-coupled superconductor.

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## BRIEFS

**SUPERGIANT-SCREEN COLOR TV--Shanghai--**China's first supergiant-screen high-luminance multi-functional color display system underwent evaluation and acceptance check on 12 December. It has reached advanced international standards of the 80s. This "Giant-Screen Color TV," jointly developed in only 10 months by the Ministry of Communications' Shanghai Shipping Transport Institute and Shanghai Vacuum Electronic Components Ltd., uses multiple microcomputer-controlled technology and has over 10 display functions, including sound advertising, television, news service, video recorder, live camera, and single-point Chinese characters. According to specialists, only three companies in the world--all in Japan and England--manufacture this system. Ninety percent of the components are made domestically, and the cost is half that of the foreign product. Before long, an 80-square-meter all-weather giant-screen color display system will tower over Shanghai's People's Square. [Summary] [40080076 Beijing RENMIN RIBAO [PEOPLE'S DAILY] (Overseas Edition) in Chinese 14 Dec 87 p 1]

**PHOTOELECTRIC DEVICE FOR VLSI--Chengdu Photoelectric Technology Institute** reports that it has developed a state priority item--a variable-rectangle electron-beam-printer laser-locator work-station system--which has reached advanced international standards of the 80s. This device uses electron-beam printing to manufacture large-scale and very-large-scale integrated circuits, a competitive technology among the world's developed countries. The institute assumed this project in 1983 and finally achieved success on New Year's Eve. [Text] [40080076 Chengdu SICHUAN RIBAO in Chinese 17 Jan 88 p 1]

**NUCLEAR POWER STATION SIMULATOR--**The Beijing Nuclear Power Station Simulation Training Center, located in Beijing's Qinghua Gardens, has undergone technical evaluation, and officially became operational a few days ago. It is China's first nuclear power station simulator, used for training nuclear station technical personnel, and is an important facility for technological research and development in nuclear power station simulation. [Text] [40080076 Shanghai JIEFANG RIBAO in Chinese 22 Jan 88 p 1]

**32-BIT SUPERMINICOMPUTER--**The KSJ-HN 2220 microminiaturized 32-bit superminicomputer, a priority S&T item for the State's Seventh Five-Year Plan, has been jointly developed by the Chinese Academy of Sciences' Shenyang Computer Technology Institute and the Huanan [South China] Computer Company, and recently underwent ministry-level technical evaluation in Shenyang. The

2220 is a new model in the 2000 series of China's Optimum computer spectrum. This model, needed in great quantities for the rebuilding of China, has reached international standards of the 80s for products of like kind. Using the KSJ-HN 2220 as the main computer, the manufacturing unit realized China's first link-up of a perfected practical network--the work-station system. [Text] [40080076 Beijing RENMIN RIBAO in Chinese 22 Jan 88 p 3]

MOBILE SATELLITE GROUND STATION--Urumqi (Xinhua), 20 Feb--A mobile satellite ground receiver, designed to fit atop an automobile, recently underwent a successful trial in the Great Desert of Tarim Bendu (i.e., the Taklimakan Desert). This motorized receiving station was built by Xinjiang Military District personnel. Under difficult geographic and atmospheric conditions, it directly receives satellite-transmitted TV programs with a clear image, thus resolving the thorny technical problem of TV reception for those personnel working in outdoor professions, such as geological prospecting and petroleum recovery. [Summary] [40080076 Beijing RENMIN RIBAO (PEOPLE'S DAILY) (Overseas Edition) in Chinese 22 Feb 88 p 4]

MICROELECTRONICS R&D BASE COMPLETED--The Shanghai Microelectronics Research and Development Center, located in Shanghai's Caohejing High-Technology-Development Park, is formally completed, and underwent acceptance check yesterday. This center is a joint venture of the Shanghai Municipal Government and the Chinese Academy of Sciences, and is based on the microelectronics research strength of the Shanghai Metallurgical Institute. Occupying 33 mu [2.2 hectares], with the buildings covering a total area of 14,000 square meters, the center has modern experimental facilities, including purification equipment and computers. Joined with the neighboring semiconductor, communications, electron optics, and automated instrument manufacturing enterprises, it makes up an organic whole for research, development, testing, and production of high-tech products. The facility will actively undertake priority projects of the State and the Chinese Academy of Sciences, and aligned with Shanghai businesses will research, develop, and manufacture products such as large-scale integrated circuits; it will also make energetic efforts to attract foreign investment. [Summary] [40080076 Shanghai JIEFANG RIBAO in Chinese 29 Jan 88 p 1]

INTELLIGENT DETONATOR--Changsha, 8 Feb--The model ZNO-1 intelligent detonator developed by the Changsha Military Engineering College of the PLA recently underwent evaluation in Changsha. This is China's first application of modern microcomputer technology to the area of demolitions. An electronic on/off switch is used to achieve electronic ignition control of the detonator. There are 8 to 24 channels, each capable of handling up to 60 amperes. Delay time is ample, safe evacuation time can be arbitrarily varied from zero to 10 minutes, and timing control error is less than 1 millisecond. This model takes the lead among domestic products of like kind; foreign countries still have not developed similar products. [Summary] 40080076 Beijing RENMIN RIBAO (PEOPLE'S DAILY) (Overseas Edition) in Chinese 9 Feb 88 p 1]

HIGH-PERFORMANCE FLOPPY DISK--Beijing (Xinhua), 12 Feb --China's largest floppy-disk production facility, the Weida [5019 6671] Magnetic Disk Factory

in Zhuhai, Guangdong Province, recently put out a high-performance floppy disk which has reached advanced international standards. This can open up new channels for China's high-quality floppy-disk exports. According to the accreditation performed by China's Magnetic Recording Technology Institute, this product's overall track quality--in terms of output amplitude, resolution ratio, overwrite noise, and other indicators--meets or exceeds that of international brands. [Text] [40080076 RENMIN RIBAO (PEOPLE'S DAILY) (Overseas Edition) in Chinese 13 Feb 88 p 1]

GUANGDONG/HONG KONG FIBER-OPTIC NET--Construction of a Guangzhou-to-Hong Kong (via Dongwan, Shenzhen, and Huizhou) fiber-optic communications network, a joint venture between Guangdong Province and Hong Kong's Dadong [Great Eastern] Telegraph Office, is being speeded up. The 217-km-long trunk line of this buried-cable single-mode optical fiber system consists of 150 km of directly buried optical cable, 55 km of pipeline optical cable, and 12 km of river cable. The entire project is being designed by the Zhengzhou [6774 1558] Planning Office of the Ministry of Posts & Telecommunications (MPT). The 199.7-km part of the route that lies within Guangdong is being constructed by three Wuhan companies under MPT; Hong Kong is responsible for construction of the segment that lies within its borders. Cable laying and equipment installation and debugging are scheduled to be completed in May of this year, with formal operation to begin in the second half of this year. [Summary] [40080081a Beijing RENMIN RIBAO (PEOPLE'S DAILY) (Overseas Edition) in Chinese 10 Feb 88 p 3]

FIBER-OPTIC BROADCASTING NET--The "BT-1986 optical-waveguide-fiber-broadcasting audio-video network" jointly developed by Tianjin University's Electronic Engineering Department and Beijing Engineering Institute has recently undergone evaluation with the support of the State Machine-Building Industry Commission. This system, with its organic unification of optical terminals and optical components, satisfies the requirements for a completely fiber-optic local area network. Essential elements are the coupler's use of the FC standard and movable connections, and the optical terminal's use of analog modulation. The system is especially suitable to: (1) wiring demonstrations of secure transmission; (2) monitoring and information on operations involving high inflammables, high explosives, toxic materials, etc.; (3) safety monitoring at nuclear power plants; (4) battlefield forward command; and (5) dynamic testing of optical components, establishment of real-time product quality norms, etc. This system can be used for fiber-optic color television transmission, e.g., from the TV center to the transmitter, and for closed-channel TV and cable TV in areas such as railroading, mining, large businesses, and schools. [Summary] [40080081b Tianjin TIANJIN KEJI XIAOXI in Chinese No 12 (Dec) 87 pp 4-5]

MAJOR BREAKTHROUGH IN IC INDUSTRY--Beijing, 29 Feb--A large-scale-integrated-circuit (LSI) computer-aided-design (CAD) system--whose development has been a



critical State project in the past 2 5-year plans--underwent national-level evaluation today in Beijing. This is China's first independently designed and developed completely functional LSI CAD system. Based on a supermini-computer and work station, it includes multiple-order software in the IC design process, which can provide logical design, circuit design, plate design and verification, test code generation, and assistance in all steps of mask making. This system's performance exceeds that of comparable products imported in recent years by some businesses, and some of the software functions have reached the international state-of-the-art. Involved in the 3-year project were almost 100 specialists from 10 closely cooperating groups including Qinghua University's Computer Department (under the Ministry of Electronics Industry), Fudan University's Electronic Engineering Department, the Chinese Academy of Sciences' Microelectronics Center, and Beijing Semiconductor Components Factory No 3. [Summary] [40080081c Beijing RENMIN RIBAO [PEOPLE'S DAILY] (Overseas Edition) in Chinese 1 Mar 88 p 1]

**MULTIPLEXING EQUIPMENT DESIGN FINALIZED--**Beijing--Design of the 56/48 and 64/32 Kbps microcomputer data multiplexing equipment developed by the Jiangsu Radio Factory was finalized in Beijing at the end of last year. This equipment uses a 16-bit 8086-2 microprocessor (CPU), combining LSI with medium- and small-scale integrated circuits. Complete digitization of the entire microprocessor's circuitry is realized, and all critical equipment functions are completed via software. It can synthesize ten kinds of dissimilar-speed data--including computer, laser printer, and teletype--into one high-speed dataflow transmission line for communications via satellite, microwave, and fiber-optic channels. This kind of equipment is used widely in TV broadcasting, electronic mail, electric power control, military command, oil-field development, and mining, and is indispensable in defense research and remote communications. Differentiated into "three national satellite ministations" and a satellite communications system, the equipment ran continuously for 1000 hours fault-free. It fully meets CCITT international standards. [Summary] [40080074a Beijing JISUANJI SHIJIIE [CHINA COMPUTERWORLD] in Chinese 27 Jan 88 p 9] /12913

**CNC MULTIPLE-SPINDLE MILLING MACHINE--**The microcomputer numerically controlled (CNC) multiple-spindle milling machine jointly developed by Southwest Jiaotong University and the Dongfeng Steam Turbine Factory has proven reliable and convenient to use after two years of operation. This system, which utilizes Chinese questioning, ISO-standard coding for the digital display, and a new type of memory--the magnetic bubble--for external storage, has greater reliability and flexibility than previous models. Its development opens new horizons for the technical transformation of domestic machine tools and has many extended applications. Economic returns are also notable: domestic machining of the type-851 blades used in 300-megawatt steam turbine units can achieve a total foreign-exchange savings of US\$3,960,000/unit, since each unit uses 198 type-851 blades costing US\$20,000 apiece to import. Detection equipment has been installed to realize closed-loop control, and machining precision is up to  $\pm 0.01$  mm. An organic programming/machining wholeness is achieved through application of the IBM-PC microcomputer-designed "Micro APT Programming System" to the milling machine. [Summary] [40080074b Beijing JISUANJI SHIJIIE [CHINA COMPUTERWORLD] in Chinese 27 Jan 88 p 12] /12913

SUPERCONDUCTOR RESEARCH PROGRESS--Beijing, 2 March (XINHUA)--Scientists at the Institute of Physics of the Chinese Academy of Sciences recently developed a new type of oxide superconductor. Its zero resistance transition temperature is about 114k and the diamagnetic susceptibility appears at 117k. The superconducting material, mainly consisting of thallium, barium, calcium, copper and oxygen, contains no rare earth elements. The scientists said the material has a stable property and its technological process can be repeated. Previously, Chinese scientists had developed a superconducting material mainly consisting of bismuth, strontium, calcium, copper and oxygen. [Text] [40100011 Beijing XINHUA in English 1309 GMT 2 Mar 88 OW] /12232

NEW SUPERCONDUCTOR COMPOUND--Beijing, 11 February (XINHUA)--Scientists at Beijing University have developed a new compound that has cast aside some old notions about superconductors. The compound, consisting of bismuth, strontium, calcium, copper and oxygen, has superconductive qualities. Tests have shown its resistance to electricity begins to drop drastically at a temperature of 114 kelvin (minus 159 degrees centigrade) and falls to zero at 84.1 kelvin (minus 188.9 degrees centigrade). Bismuth replaces the [words indistinct] in previous compounds. The new compound has negated the assumption that only rare-earth material could make ideal superconductors, the scientists said, adding it has opened new ways for finding better superconductivity materials. Bismuth has one other advantage, they noted. It is much cheaper than yttrium. [Text] [40100011 Beijing XINHUA in English 0735 GMT 11 Feb 88 OW] /12232

## BRIEFS

**VIRUS-RESISTANT TOBACCO PLANT**--The Research Institute of Microbiology, Chinese Academy of Sciences, has obtained a transformed cucumber floral leaf virus-resistant tobacco plant by incorporating its newly synthesized cucumber floral leaf virus-resistant gene into tobacco plants. The project was focused on cucumber floral leaf virus because of its damage to valuable crops such as vegetables, melons, tobacco, oil crops, medicinal herbs, and 775 other kinds of crops, and its extensive reduction of crop production through infection. The introduction of disease-resistant engineering techniques can increase production from 10 to 30 percent or more, and the economic value will be tremendous if virus-resistant gene engineering is further applied to virus-sensitive dicotyledons. [Summary] [Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 10 Feb 88 p 1] /9604

**SOYBEAN PLANTS REGENERATED FROM CELL PROTOPLASTS**--After several years of studying soybean tissue culture and breed selection, the Shanghai Research Institute of Plant Physiology has succeeded in its protoplast plant regenerating project. The achievement provides crucial techniques for soybean genetic engineering research. Protoplasts are naked cells which are very useful for genetic research because of the advantage of their capability to introduce new genetic material from outside sources for hybridization purposes. [Summary] [Beijing GUANGMING RIBAO in Chinese 3 Jan 88 p 1] /9604

CSO: 40081049

## EXPERIMENTS TO INCREASE BACILLUS THURINGIENSIS TOXICITY

40081040a Beijing WEISHENGWUXUE TONGBAO [MICROBIOLOGY] in Chinese Vol 14 No 5, Oct 87 pp 197-199

[Article by Zuo Changzhi [1563 1603 2535], Chen Li [7115 7787], Shao Yongchang [5135 3057 2490], and Lu Jianfang [0712 1696 5364], Laiyang Municipal Health and Epidemic Prevention Station, Shandong Province: "Study of Conditions in Which Bacillus Thuringiensis var Israelensis Produces Toxins"]

[Text] Abstract: Experiments conducted on the effects of toxin producing conditions on the ability of *Bacillus thuringiensis* var *israelensis* to produce toxin show the following: Various suitable conditions for increasing the ability of the bacillus to produce toxin are as follows: Toxin production is promoted most when the source of nitrogen is peanut cake, and peptone is second; urea has a marked inhibiting effect. Glucose, maltose, glycerin, and starch as sources of carbon have a promoting effect. Six different kinds of growth promoters tested showed varying degrees of increased ability to produce toxin.  $Mg^{++}$  and  $Ca^{++}$  had a marked promoting effect, and  $Mn^{++}$  had a marked inhibiting effect. The most suitable pH was 7.0 - 7.5, and the most suitable temperature was 28 - 32 degrees C. The most suitable volume of fluid in a 500 ml flask was less than 100 ml, and the bacteria's toxin producing ability was strongest when culturing was done for 24 hours.

In 1977, Goldberg[1] separated a strain of *Bacillus thuringiensis* from Israel termed *Bacillus thuringiensis israelensis*, which possessed high toxicity for mosquito larvae. Numerous search reports have already been written about this[2-4]. The safety level of experiments using this bacillus has reached the point where it can be used in experiments to wipe out mosquito larvae in large bodies of water[5,6]. However, no reports have appeared in China as yet about systematic study of fermentation conditions on the ability of *Bacillus thuringiensis* var *israelensis* to produce toxin. This article studies fairly systematically the various factors involved in increasing the ability of this bacillus to produce toxin, the results of which are provided below.

## Materials and Methods

### (1) Bacillus Strain

*Bacillus thuringiensis* var *israelensis*, strain 1897 was provided by the Animal Research Institute of the Chinese Academy of Sciences.

### (2) Culturing Medium (g)

1. Peanut cake 5; distilled water, 100 ml at a pH of 7.2-7.6[7]
2. Peptone 1; beef extract 0.5; distilled water 100 ml, pH 7.2-7.6[8].
3. Yeast 0.3; NaCl 0.5; distilled water 100 ml at a pH of 7.2-7.6

### (3) Culturing Method

To a 500 ml flask, 40 ml of culturing medium was added and inoculated after the bacteria were killed. A Chinese produced Model THZ-82 bench type constant temperature oscillator vibrated the mixture at a rate of 180 to 200 revolutions per minute at 30 degrees C during culturing for 48 hours.

### (4) Testing of Toxicity

Toxicity was tested using the standard method recommended by the WHO Conference of Biological Prevention and Treatment Experts[9], and the bacillus powder used was provided by the French Pasteur Institute, its IPS-78 titer being 1,000 IU/mg. The mosquito larvae provided for the experiment were from a strain of pale ku [1655] mosquito larvae that the insect laboratory had been growing for nearly three full years. The bacteria counting method was the dilution-plate method.

## Results and Discussion

### (1) Effects of Nitrogen Source on Toxin Producing Ability

To two culturing mediums, one of them consisting of 0.3 percent yeast, and the other consisting of 0.5 percent sodium chloride, was added various nitrogen containing organic materials and inorganic materials, media to which nothing had been added serving as a control. Results are shown in Table 1.

Table 1

**Effects of Different Nitrogen Sources on the Toxin Producing  
Ability of *Bacillus Thuringiensis* var *Israelensis***

Kinds of Nitrogen Sources	Concentration (%)	Converted To Standard Nitrogen (%)	Number Of Bacteria (100 million/ml)	Toxicity Titer (IU/MG)
Peptone	1.0	$1.3 \times 10^{-3}$	4.3	29
Peanut Nitrate	1.0	$1.2 \times 10^{-3}$	8.2	79
Ammonium Nitrate	1.4	$4.9 \times 10^{-3}$	1.35	3.3
Ammonium Sulfate	2.0	$4.2 \times 10^{-3}$	1.0	3.0
Urea	1.0	$4.7 \times 10^{-3}$	0.07	0.8
Nothing	0	0	0.04	1.9

Note: Average values from results of five experiments

Table 1 shows marked differences in growth and development and in toxin producing ability when *Bacillus thuringiensis* var *israelensis* is cultured in media containing different nitrogen sources. When urea, with a high nitrogen content, was added to the culturing medium, growth and development was markedly inhibited; the number of bacteria was extremely small; the bacteria were short and thick; and when culturing was finished, none of the classic crystals appeared; and toxicity was twice again as low as for the media to which no organic material had been added. When peanut protein, peptone, ammonium nitrate and ammonium sulfate nitrogen sources were added to the culturing media, growth and development was virtually identical, though there were marked differences in levels of toxicity ( $P < 0.01$ ). Toxicity was highest for organic nitrogen with the lowest nitrogen content, and among the materials containing nitrogen, toxicity was highest from the peanut protein of plant origin, more than 49 times again as high as from the media to which nothing had been added. Analysis shows peanut protein to contain 18 different amino acids, the highest percentage of which are glutamic acid and aspartic acid. This happens to be close to the amino acids contained in the crystalline protein of the *Bacillus thuringiensis* [8]. The other nitrogen sources were markedly different. This may be the main reason why peanut protein is superior to the other sources of protein. Smirnoff has reported an inhibiting rate of between 20 and 100 percent [10] on *Bacillus thuringiensis* brood spore and companion spore crystal formation from 0.4 M of urea. In the case of *Bacillus thuringiensis* var *israelensis*, just 0.15 M of urea produced a marked inhibiting effect.

## (2) Effects of Carbon Sources on Toxin Production

A 1 percent peptone and a 0.5 percent beef extract solution were used as culturing media. To these was added 0.5 percent of various different kinds of carbon sources, with other media to which nothing had been added serving

as controls. The results (shown in Table 2)) demonstrate that glucose, maltose, glycerin and starch promote the growth of *Bacillus thuringiensis* var *israelensis*, and are able to increase its toxin producing ability. Sorbitol and cane sugar, though able to stimulate growth, could not increase toxin production.

Table 2  
Effects of Different Carbon Sources on the Toxin Producing  
Ability of *Bacillus Thuringiensis* var *Israelensis*

Kinds of Carbon Sources	Concentration (%)	Number of Bacteria (100 million/ml)	Toxicity Titer (IU/MG)
Glucose	0.5	5.7	25
Maltose	0.5	6.15	28
Cane Sugar	0.5	3.6	15
Glycerin	0.5	3.0	27
Starch	0.5	5.7	28
Sorbitol	0.5	3.85	14
Nothing	0	2.5	14

Note: Average values from results of four experiments

### (3) Effects of Growth Factor on Toxin Production

To culturing media consisting of 1 percent of peptone, and 0.5 percent beef extract were added six different growth factors including thiamine and riboflavin. Their effects on the growth and development, and on the toxin production of *Bacillus thuringiensis* var *israelensis* are shown in Table 3. The Table 3 results show different growth promoting effects for the six different growth factors at the concentrations used in this experiment ( $t > 3$ ), though they were able to boost toxin production, biotin having the greatest effect.



Table 3

Effects of Different Growth Factors on the Toxin  
Producing Ability of *Bacillus Thuringiensis* var *Israelensis*

Growth Factor	Concentration (ug/ml)	Number of Bacteria (100 million/ml)	Toxicity Titer (IU/MG)
Thiazine	5.0	4.5	5.0
Riboflavin	5.0	4.0	4.4
Nicotinic Acid	10.0	3.6	4.3
Pyradoxine	10.0	3.75	4.8
Biotin	0.013	3.55	5.8
Folic Acid	0.12	4.4	4.7
Nothing	0	3.0	3.3

Note: Average values from results of four experiments

Table 4

Effects of Metal Ions on the Toxin Producing  
Ability of *Bacillus Thuringiensis* var *Israelensis*

Metal Ion	Toxicity Titer (IU/mg)	Concentration (mg/ml)				
		0.05	0.1	5	10	None
	Ca++	7.1	7.1	8.3	9.4	6.5
	Mn++	3.8	3.8	3.0	<1.5	6.0
	Mg++	62.5	50.0	34.9	31.9	14.3
	K+	10.0	6.5	6.3	6.3	6.8

Note: Average values from results of five experiments

One reference[11] has reported that when the growth of *Bacillus thuringiensis* var *israelensis* goes from the logarithmic phase to the steady phase, an ectoprotease is produced. The function of this enzyme, according to research done by Rogoff[12], is to take part in the protein conversion process in the companion spore crystal formation process. The formation or activation of this enzyme in the culturing medium required the addition of Ca++, Mn++, and Mg++. We added different concentrations of Ca++, Mn++, Mg++, and K+ to a 1 percent peptone and a 0.5 percent beef broth culturing medium to perform an experiment. The results (given in Table 4) showed that the addition of Ca++ and Mn++ to the culturing media markedly increased toxin production by the *Bacillus thuringiensis* var *israelensis*; however, the promoting effect of Ca++



increased as the concentration increased. For  $Mg^{++}$ , the promoting effect decreased as the concentration increased. When the concentration of  $K^+$  was lower than 0.05 mg/ml, there was a promoting effect; when the concentration was greater than 0.1 mg/ml, there was no marked effect.  $Mn^{++}$  had a marked inhibiting effect, and the higher the concentration, the greater the inhibiting effect.

#### (5) Correlation between the Amount of Fluid and Toxin Production

Different volumes of a 5 percent peanut cake culturing medium were put into 500 ml triangular flasks and inoculated with the bacillus, which was cultured for 48 hours at 30 degrees C, and then the bacteria were counted and toxicity was tested. Results are shown in Table 5.

Table 5  
Correlation Between Amount of Fluid and the Toxin  
Producing Ability of *Bacillus Thuringiensis* var *Israelensis*

Amount of Fluid	Final pH	Number of Bacteria (100 million/ml)	Toxicity Titer (IU/mg)
30	8.5	3.3	197
40	8.5	3.4	190
60	8.5	3.3	190
80	8.5	3.0	210
100	8.5	3.3	197
150	7.5	1.9	39
200	7.0	2.0	9
250	6.5	0.5	2.3

Note: Average values from results of four experiments

Table 5 shows that different volumes of culturing medium fluid had a marked effect on the growth and toxin producing ability of *Bacillus thuringiensis* var *israelensis*. When the amount of fluid was between 30 and 100 ml, and the final pH was 8.5, there was no marked difference ( $t < 2$ ) in the number of bacteria and the toxicity titer, but when the amount of fluid was greater than 100 ml, ability to produce toxin declined as the volume of fluid increased. Thus, it appears that the amount of fluid should not be too great, and that the amount of ventilation should be properly increased during fermentation in order to boost the bacteria's toxin producing ability.

#### (6) Preliminary Testing of the Effect of pH on Ability to Produce Toxin

Either NaOH or HCl were used to adjust the 5 percent peanut cake culturing medium pH to between 3 and 13. After the bacteria were killed, inoculation was made and culturing was done for 48 hours after which toxicity was tested (4 times). This experiment showed growth and ability to produce toxin at pH

5 - 11, the optimum being pH 7.0 - 7.5. At below pH 5 or above pH 11, growth and development of the *Bacillus thuringiensis* var *israelensis* was markedly inhibited. It could not form blood cells, and it lost ability to produce toxin.

#### (7) Correlation between Culturing Time and Ability to Produce Toxin

*Bacillus thuringiensis* var *israelensis* was cultured in a shaking flask for different periods of time after which samples were applied to a slide for microscopic examination and stored in a refrigerator at 4 degrees C. Bacteria were counted and toxicity tested (5 times) under identical conditions. It was discovered that after culturing for between 2 and 4 hours, brood cell germination produced evenly colored trophozoites, and that large scale reproduction had begun. After between 6 and 9 hours of culturing, there was marked agglutination of protoplasm and marked division into spores at one end and dot shaped crystalline sporangia at the other end, which entered the autolysis stage after 24 hours. After culturing for 12 hours, marked insect killing activity appeared. After 24 hours, both the number of bacteria and their toxicity reached a high level, but after 120 hours, there was no marked increase in toxicity.

#### (8) Correlation Between Culturing Temperature and Toxin Producing Ability

A culture of *Bacillus thuringiensis* var *israelensis* that had been cultured at different temperatures was stored in a refrigerator at 4 degrees C, and then toxicity testing and bacteria counting was done under identical conditions (4 times). Results showed the bacteria were able to grow at between 10 and 40 degrees C, and though the number of bacteria in the culture were virtually identical at between 24 to 36 degrees C, toxicity crested at between 28 and 32 degrees C. At lower than 28 degrees C or higher than 32 degrees C, toxin producing ability declined. At between 10 and 20 degrees C, development of bacteria colonies slowed and ability to produce toxin slowed. When the temperature exceeded 36 degrees C, growth and development accelerated; however, the bacteria became prone to senescence, and toxicity was at an extremely low level.

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## NEW METHOD TO ANALYZE MUTAGENIC POTENTIAL OF GENOTOXICANT AT LOW DOSES

40081051 Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY (NATURAL SCIENCES)] In Chinese Vol 26 No 4 Dec 87 pp 461-462

[Article by Su Zhaozhong [5685 0340 5883], Department of Biology, Fudan University]

[Text] This article introduces a new method to analyze a low dose DNA toxicant system -- virus H-1/human cell NB-E system. The fine virus H-lts6 (H-1 thermolabile mutant) treated with a certain dose of DNA toxicant (e.g., 254nm ultra-violet) has its specific survival rate ( $S_0$ ) and its mutation frequency ( $Mf_0$ ) in NB-E cells cultured in vitro. If the host cells are treated with a low dose DNA toxicant before being infected with H-1 virus, the viral survival rate (S) and mutation frequency (Mf) correspondingly increases, thus, ER (strengthened recovery of injured virus)= $S/S_0$ , and EM (Strengthened mutation)= $Mf/Mf_0$ , therefore ER and EM could be used as an indicator to measure the mutation potential of low dose DNA toxicant. Tests of eight kinds of DNA toxicants using H-lts6/NB-E system (Table 1) showed the survival rate of 85 JH<sup>-2</sup> u.v.-treated fine virus H-lts 6 in untreated NB-E cells was  $1.1 \times 10^{-4}$  (viral survival rates were taken by plaque method, one plaque representing one surviving infectious virus).

Table 1. ER and EM of various DNA Toxicants\*

DNA Toxicants (Dosages)	Viral Survival Rates ( $\times 10^{-4}$ ) **	ER	Viral Mutation Frequency ( $\times 10^{-5}$ )	EM
-	$1.1 \pm 0.10$	-	$1.51 \pm 0.21$	-
254nm u.v. ( $4.5 \text{ Jm}^{-2}$ )	$2.30 \pm 0.21$	2.1	$4.15 \pm 0.35$	2.7
X-rays (0.8Gy)	$2.20 \pm 0.20$	2.0	$3.31 \pm 0.28$	2.2
MethanosulfoMethyl Ester (1mM)	$2.11 \pm 0.23$	1.9	$3.02 \pm 0.25$	2.0
Mitomycin (5 $\mu\text{g/ml}$ )	$1.95 \pm 0.15$	1.7	$3.20 \pm 0.25$	2.1
7,12-dimethyl Anthracene (5 $\mu\text{g/ml}$ )	$2.15 \pm 0.24$	2.0	$3.40 \pm 0.36$	2.2
Aspergillin B (3 $\mu\text{g/ml}$ )	$2.28 \pm 0.25$	2.1	$3.51 \pm 0.30$	2.3
Hydroxyl Urea (2mM)	$1.58 \pm 0.15$	1.4	$2.43 \pm 0.30$	1.6
Methyl Nitrosourea (5 $\mu\text{g/ml}$ )	$2.01 \pm 0.20$	1.8	$3.41 \pm 0.24$	2.2

\*Time interval of treating cells with DNA toxicants and viral infections was 12-16 hours

\*\*The values were averages of three independent experimental results.

Under restricted temperature (39.5 degrees C), H-lts6 could not complete its reproduction cycle because of its functional damage in the anaphase of the reproduction process, the recovered mutant H-lts6 virus could still form plaques even at 39.5 degrees C temperature, and the viral mutation frequency was the plaque formation ratio of equal titers of virus in 39.5 degrees C and in 33 degrees C. Table 1 indicated that the tested DNA toxicants could remarkable change viral ER and EM, and the inducing potential of seven DNA toxicants that could directly react with DNA molecules were much greater than that of hydroxyl urea- a DNA synthesis inhibitor.

ER and EM induction showed parallel relationship between viral kinetic process and toxicant dosage effects. When the low-dose DNA toxicant treated cells are infected with virus at different intervals, the viral ER and EM rises with the increase of time, and reach their maximum value at 12-18 hours after infection; then ER and EM gradually decline and eventually disappears. Also, viral ER and EM rise with increased dosage in the low-dose range, but they decline when the dosage is greater than cellular sub-lethal dosage ranges (cell survival rate is 80 percent), and viral ER and EM expressions are simultaneously inhibited as the inhibitor aceticomycete ketone- a resynthesized protein from eukaryotic cells- is added during the inducing process (Table 2).

Table 2. Inducing Effect of Aceticomycete Ketone (CH) on ER and EM \*

Inducers (Dosages)	ER		EM	
	-CH	+CH	-CH	+CH
254nm u.v. ( $4.5\text{Jm}^{-2}$ )	2.10	1.02	2.70	1.12
Mitomycin (5ug/ml)	1.70	1.05	2.10	0.95
Hydroxyl Urea (2mM)	1.40	0.94	1.60	1.02

\*The concentration of aceticomycete Ketone was 5 g/ml which could not affect cellular survival

This means that viral ER and EM may be controlled by the related control mechanism or they may be two different expressions of the same hereditary process, and they need the induction of a resynthesized protein such as aceticomycete ketone.

Fine virus H-1/human cell NB-E analysis system was superior to other systems because its (1) Sensitivity--H-1/NB-E system could directly measure low-dose DNA toxicants in the environment that were easily underestimated by other systems. (2) Reality--H-1/NB-E system directly analysed the mutation process of human cells. (3) Broad-Spectrum--H-1/NB-E system could test different DNA toxicants with different damaging mechanisms, because they could all induce strengthened recoveries and mutation.

Since H-1 virus was constituted by single-chain thread-like DNA molecules, a blocking injury on the chain would cause death to the virus, unless the induced recovery mechanism could repair the damage by bypassing the blockage,

then the virus could complete its reproduction process. The enhanced viral recovery process was bound to be accompanied by enhanced viral mutation, and the recovery process needs the induction of resynthesized protein from eukaryotic cells because of similarity of viral ER and EM to Weigle recovery and Weigle mutation processes of the protokaryons. The principle thrust of this research was to provide a new evidence for the possible SOS function in the mammal cells.

/12913

SCREENING OF RESISTANT RESOURCE, GENETIC ANALYSIS OF RESISTANCE TO WHITEBACKED  
PLANTHOPPER IN RICE VARIETIES

40091040a Beijing YICHUAN XUEBAO [ACTA GENETICA SINICA] in Chinese Vol 14  
No 6, Dec 87 pp 413-418

[English abstract of article by Li Ximing [2621 6007 2494], et al., of the  
China National Rice Research Institute, Hangzhou]

[Text] Six varieties of rice (Oryza sativa L.) resistant to the whitebacked  
planthopper (WBPH) Sogatella furcifera (Horvath) were obtained. Genetic  
analysis of resistance showed a single dominant gene governing the resistance  
in the varieties individually. The gene for HA79317-7 is allelic to Wbph 1  
and that for Dianti 336-3 is allelic to Wbph 2, while the genes for Guiyigu,  
Dahuagu, Daqigu and Biangu are nonallelic to Wbph 1 and Wbph 2.

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STUDIES OF DNA SYNTHESIS OF MICRONUCLEI INDUCED BY IRRADIATION USING  
MICROAUTOGRAPHY. I. EFFECTS OF DIFFERENT DOSES

40091040b Beijing YICHUAN XUEBAO [ACTA GENETICA SINICA] in Chinese Vol 14  
No 6, Dec 87 pp 419-423

[English abstract of article by Li Shuxian [2621 3219 8300] of South China  
Normal University, Guangzhou; Liu Zhensheng [0491 2182 5116] of Zhongshan  
University, Guangzhou]

[Text] In this experiment,  $^3\text{H}$ -TdR was used to label the Vicia faba root tip  
cells irradiated by different doses in order to study DNA synthesis of micro-  
nuclei through microautography. The experimental results show that it is  
significant that the different doses of  $\gamma$ -rays could influence the DNA  
synthesis of micronuclei. The frequency of labeled micronucleate cells,  
as well as that of micronuclei, decreased with an increase in the dose.

This paper emphasizes that micronuclei may be useful in cytogenetic engineer-  
ing based on the labeled types of micronucleate cells.

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## HLA-DR, cDNA SUBPROBES REDUCE COMPLEXITY OF RFLP FOR DR TYPING

40091040c Beijing YICHUAN XUEBAO [ACTA GENETICA SINICA] in Chinese Vol 14  
No 6, Dec 87 pp 460-467

[English abstract of article by Fei Hongming [6316 5725 2494] of the Department of Biology, Shanghai Second Medical University; Marcel Tilanus, Marja van Eggermood and Marius Giphart of the Department of Immunohematology and Blood-bank, University Hospital, Leiden, Netherlands]

[Text] The identification of HLA-DR alleles at the DNA level is a complementary typing technique applicable to any nucleated cells. Although it is as yet unknown whether the DNA polymorphism detected in homozygous typing cells with unambiguous DR types defined by serotyping is of functional significance, it is reasonable, at the present status, to include DNA polymorphisms in the DR typing. One of the major problems in DNA typing is to have the complex patterns of the hybridized DNA fragments logically interpreted. This is a particular problem involving heterozygous individuals. Aiming at reducing the number of hybridized DNA fragments and, therefore, the complexity of RFLP, the authors constructed subprobes from the full-length DR $\beta$ , DQ $\beta$  and DQ $\alpha$  cDNA probes. It was found that genomic DNAs isolated from unambiguously serotyped HTC cells, digested with PvuII, and hybridized to a DR $\beta$  3' subprobe containing 3' untranslated region sequences, showed RFLP patterns distinct among DR alleles. Although further characterization is needed for DNA typing to be a practically feasible technique, the simplified patterns of the hybridized DNA fragments facilitate the DNA typing in individuals heterozygous for some haplotypes. It has been found that the number of hybridized DNA fragments corresponds to the number of DR $\beta$  genes in DR1-DRw8 haplotypes. Moreover, the results show that DR3, DR5 and DRw6 have a common hybridization pattern, suggesting that they might have evolved from a common ancestral gene. The same situation was seen in DR4, DR7 and DRw9, which might have evolved in a similar manner.

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CLONING OF PHAGE T5 DNA FRAGMENTS POSSESSING PROMOTER FUNCTION IN BACILLUS SUBTILIS

40091040d Beijing YICHUAN XUEBAO [ACTA GENETICA SINICA] in Chinese Vol 14  
No 6, Dec 87 pp 468-474

[English abstract of article by Li Bongsok, Visiting scholar from the DPRK;  
Li Yuyang [2621 5148 7122] of the Institute of Genetics, Fudan University,  
Shanghai]

[Text] Using the promoter probe plasmid pTG402 as a vector, the MboI fragments of E. coli bacteriophage T5 DNA have been cloned. About 2 percent of the clones contain the inserts with promoter functions. The recombinant plasmid pTG402-20 is the clone, containing the strongest promoter. The results of DNA-DNA hybridization show that the insert fragment of pTG402-20 is from the G and B fragments of T5 DNA HindIII digests. The insert is about 0.84 kb.

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CLONING OF PROMOTERS OF ALKALOPHILIC BACILLUS SP NO 2, EFFECT OF SOME FACTORS  
ON EXPRESSION

40091039a Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese  
Vol 27 No 4, Dec 87 pp 322-328

[English abstract of article by Chen Yongqing [7115 3057 7230], et al., of the  
Department of Biology, Fudan University, Shanghai]

[Text] A strain of alkalophilic Bacillus was isolated from soil, and its  
fundamental characteristics were examined. The authors cloned fragments  
containing promoters from its chromosomal DNA with the vector of promoter-  
deletion plasmid pGA46 in E. coli, and found them to be expressing well.  
Some of these promoters were controlled by environmental factors, such as pH  
and NaCl concentration.

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INDIGENOUS PLASMID IN PSEUDOMONAS SOLANACEARUM FROM CHINA, ITS PATHOGENICITY

40091039b Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese  
Vol 27 No 4, Dec 87 pp 329-335

[English abstract of article by Xie Daoxin [6200 6670 2500], et al., of the Molecular Biology Laboratory, Chinese Academy of Agricultural Sciences, Beijing; He Liyuan [0149 4409 6678] of the Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing]

[Text] It was found that 14 of 51 wild strains of Pseudomonas solanacearum and 10 of 20 "mutant" strains of P. solanacearum carried 1 or 2 plasmids of molecular weight from less than 5 to 120 megadaltons. In wild strains Ss1, Sn1, E4, Pe2, Tm9, Z2, P3, Pol, Po3 and Po4 and their "mutant" strains ASs1, Asn1, AE4, APe2, ATm9, AZ2, AP3, APol, APo3 and APo4, no plasmids were harbored. Plasmids of wild strains M5, M6, E1 and P9 had the same molecular weights as those of their respective "mutant" strains, AM5, AM6, AE1 and AP9. Therefore, no relationship existed between the presence of plasmid and pathogenicity of the mentioned strains of P. solanacearum. However, wild strains P7, P8, Z1, Z3, M2 and Po41 contained no plasmids, while plasmids appeared in their "mutant" strains AP7, AP8, AZ1, AZ3, AM2 and APo41. In this case, it is likely that the plasmid is associated with the pathogenicity of the strains. Studies of the homology between plasmid DNA of "mutant" strains (AP7, AP8, AZ1, AZ3, AM2 and APo41) and chromosomal DNA of their wild strains are in progress.

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CHARACTERISTIC ANALYSIS OF E. COLI PLASMID MUTANT (p#GTE5)

40091039c Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese  
Vol 27 No 4, Dec 87 pp 336-342

[English abstract of article by Chen Yuexian [7115 2588 0103], et al., of the  
Department of Biology, Beijing University]

[Text] The  $\beta$ -lactamase gene of E. coli RRI plasmid (pGTE5) could express in both E. coli and Bacillus subtilis, but the extracellular  $\beta$ -lactamase activity and resistance to Ampicillin in E. coli was very low. In order to increase the  $\beta$ -lactamase activity of the plasmid (pGTE5), the E. coli RRI (pGTE5) strain was induced by both UV (30 w, 40 cm, 150 s) and diethyl sulfate. A plasmid mutant (p#GTE5) was selected by increasing its resistance to Ampicillin (Ap).

E. coli cells with the plasmid mutant (p#GTE5), which cloned the  $\beta$ -lactamase gene of Bacillus licheniformis, were able to secrete a large amount of protein into the culture broth. The extracellular  $\beta$ -lactamase activity and resistance to Ampicillin was about 10 times that of cells containing the normal plasmid (p#GTE5). The  $\beta$ -lactamase gene could express after transformation of (p#GTE5) DNA into Bacillus subtilis spheroplast. The plasmid mutant (p#GTE5) remained a shuttle plasmid.

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## STUDIES OF CHARACTERISTICS OF HIGHER TOBRAMYCIN PRODUCER

40091039d Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese  
Vol 27 No 4, Dec 87 pp 357-361

[English abstract of article by Zhang Huide [4545 1979 1795], et al., of the  
Institute of Microbiology, Chinese Academy of Sciences, Beijing]

[Text] Spores of Streptomyces tenebrarius 410-II were treated with high temperatures and N-methyl-N'-nitro-N-nitrosoguanidine. Six mutants without pigment were isolated. These mutants produced only two components, Carbamoyl-tobramycin and Apramycin, but no Carbamoyl-kanamycin. The ratio of the two components was 1:1. These mutants produced no pigment in agars. The filter broth did not turn purple when treated with an FeSO<sub>4</sub> solution. This is advantageous for purification of the antibiotic. The total titer of the antibiotic produced by the mutant W1028-M5 was about 20 percent higher than that of the original strain 410-II. The Carbamoyl-tobramycin was increased by about 45-50 percent. Due to the lack of one component of the antibiotic complex, the efficiency of the isolation and purification of the antibiotic was increased. The recovery efficiency of tobramycin reached 25 percent. Therefore, the mutant W1028-M5 is an available producer of tobramycin.

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CONSTRUCTION OF TYPHOID-DYSENTERY BIVALENT STRAIN WITH TYPHOID Ty21a,  
DYSENTERY T32-ISTRATI STRAINS

40091039e Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese  
Vol 27 No 4, Dec 87 pp 362-368

[English abstract of article by Chen Qiyuan [7115 3823 1254], et al., of  
Lanzhou Institute of Biological Products, Ministry of Public Health]

[Text] *Bacillus dysentery* is a widespread enteric disease in China. Although there has been an obvious decrease in morbidity in recent years with improvements in hygiene conditions, serious problems exist involving its control. The authors have been trying to develop a dysentery vaccine to prevent this infectious disease for years. The efforts to select a candidate live bivalent vaccine strain are directed toward this goal.

The construction of a typhoid-dysentery bivalent strain was achieved through recombination in vivo using the avirulent strain typhoid Ty21a, selected and used as a vaccine strain by Germanier in Switzerland, and the dysentery T32-Istrati strain used in Rou . . . The hybrid strain contributes to the serological properties of both of its parent strains in that it can stimulate the antibody formation specific to Salmonella typhoid and Shigella flexneri 2a strains with high titers. It offers 80 percent protection from infection in the Rhesus monkey when immunized three times using a total dosage of about  $1450 \times 10^8$  viables and challenged with a virulent strain of flexneri 2a 15 days after the last dose. It also protects against an infective dose of virulent typhoid strains (Ty2) when tested with C<sub>3</sub>H mice. It maintains stability after 30 passages on agar slants and the Sereny test is negative. The safety of this strain was tested on 101 people through oral administration using  $157-200 \times 10^8$  viables and no illness occurred. The authors believe it to be a promising candidate vaccine strain.

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ISOLATION, IDENTIFICATION OF CLOSTRIDIUM BOTULINUM TYPE D STRAIN

40091039f Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese  
Vol 27 No 4, Dec 87 pp 369-373

[English abstract of article by Wang Yinchun [3769 5593 2797], et al., of Lanzhou Institute of Biological Products; Gao Qingyi [7559 1987 0308] of the Food Hygiene Control and Inspection Institute, Ministry of Public Health, Beijing]

[Text] A strain of Clostridium botulinum was isolated from a culture of sea mud in the East China Sea. The strain, D85501, was identified as Clostridium botulinum type D based on its bacteriological, serological and toxicological characteristics, gas chromatography analysis of the bacterial metabolite and DNA G+C mol percent determination.

In comparison with the international reference strain D359, the D85501 strain has good capability to produce toxins and spores. Its spores are more resistant to boiling than are D359 ones. The toxins produced by these two strains can only be neutralized by type D typing antiserum when they are diluted. They share some common antigens, as does the C314/91 (C<sub>Q</sub>) strain, but are not entirely identical. Therefore, partial cross-neutralization occurs among them, but no common antigens with type A, B, E or F botulinum toxin were shown. The gas chromatography analysis of bacterial metabolites and DNA G+C mol percent determination of the D85501 strain are also in accordance with the main key for identifying type D botulinum.

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NEW SPECIES OF STREPTOMYCES--PRODUCING FUJANMYCINS A, B

40091039g Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese  
Vol 27 No 4, Dec 87 pp 374-376

[English abstract of article by Yu Qiwei (0060 0366 0251), et al., of the  
Institute of Antibiotics, Chinese Academy of Medical Sciences, Beijing]

[Text] Streptomyces strain No 114 was isolated from a soil from Fujian Province. The strain can be used to produce new antibiotics--Fujanmycin A and B. Its aerial mycelium is white to dull white and the substrate mycelium is not fragmented. It possesses a type I cell wall composition. The strain belongs to the genus Streptomyces. A comparison of strain No 114 with related species shows that they are very different. Streptomyces strain No 114 was, therefore, identified as a new species and was named Streptomyces fujanmyceticus n. sp. Yan, Zhang, Yu 1985.

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STUDIES OF NEW SPECIES OF CHAINIA

40091039h Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese  
Vol 27 No 4, Dec 87 pp 380-383

[English Abstract of article by Chen Liren [7115 4409 0088], et al., of  
Guangxi Academy of Agro-Sciences, Nanning]

[Text] Chainia 7116-20 was isolated from a soil sample collected from Yaxian, Guangdong Province, China. It was found to produce two antibiotics--one is an antifungal effective against plant pathogens, while the other is an antibacterial against gram-positive and gram-negative bacteria. From the paper chromatography, the antibacterial active component had the same Rf values as that of Chainia yaxianensis. Further research will be reported in another paper.

On various agar media, the aerial mycelia were gray to blue-black and the substrate mycelia were blue-black, without melanoid pigments. Mature spore chains were rather short, often with 8 to 10 spores per chain, and the spores were cylindrical, the spore surface was smooth under EM and sclerotia was formed on glycerol-asparagine agar. The autolysis of aerial mycelia was absorbed to moisture. The cell wall chemical composition was of type I.

According to morphological, culture and biochemical characteristics, this differs from all Chainia species described in the literature. Therefore, it is thought to be a new species of Chainia and has been named Chainia hygroatrocyanea n. sp. Yan et al.

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## BRIEFS

ANTI-E.P. PLASMA BURN TREATMENT--A pseudomonas endotoxin protein-resistant super immune plasma has been extracted from bacillus *Pseudomonas aeruginosa* by a joint research team from the Shanghai Blood Center, the Shanghai Ruijin Hospital of the Second Medical University, and the Applied Microbiology Research Institute of Heilongjiang Academy of Sciences. After Clinical tests in the Burn Department of Ruijin Hospital, it was proved that the extracted anti-E.P. plasma could effectively control pseudomonas aeruginosa infection in burn patients. [Summary] 40081048 Shanghai JIEFANG RIBAO in Chinese 21 Dec 87 p 2 /12232

## DEVELOPMENT STRATEGIES FOR NATIONAL DEFENSE S&amp;T NETWORKS

40080022 Beijing KEXUE QINGBAO GONGZUO [SCIENTIFIC AND TECHNICAL INFORMATION WORK] in Chinese Aug 87 pp 4-5

[Article by Pan Biao [3382 1753] and Liu Zheng [0491 2398]: "A Discussion of Development Strategies for National Defense Scientific and Technical Information Networks"]

[Text] National defense S&T information networks (including local information stations and coordination groups) are cooperative organizations formed voluntarily for "joint efforts and mutual benefit." For a substantial time in the future, they will occupy a central and nuclear status in national defense S&T information systems, and they will become core organs which transmit policymaking information and news in coordination with the development of all fields and specializations in national defense S&T. They will play the roles of guides, mediators, bridges, and feedback. Horizontal integration is the developmental orientation of the construction of S&T information systems. During activities to organize information networks, the role of administrative systems will be reduced to a secondary status and gradually wither away, while the roles of professional ties and horizontal integration will move into first place and gradually come to play the primary role. For this reason, during work to coordinate and organize S&T information networks, the orientation is toward transition from administrative management to service management. The fundamental experiences which link reforms in economic systems with those in S&T systems, making reality the starting point in reforms in S&T information systems, and making reforms in national defense S&T information systems also require that we begin with the commercialization of information for gradual industrialization of S&T information networks and thus achieve socialization. In a competitive environment, information networks must improve their capacities for self-adaptation and self-development. Given these basic points, we must acknowledge that questions of development strategies for S&T information networks are necessary and beneficial.

#### 1. The Strategic Goals of National Defense S&T Information Networks

To adapt to the new situations in reforms in economic system and S&T systems, and to provide better service to national defense S&T information networks and construction of the national economy, national defense S&T information networks should develop gradually into integrated development groups for national defense S&T information.

1. Every network should gradually become an integrated body with a true capacity for self-adaptation and be capable of providing the information required for integrated competition within the national defense industry and competition among the member units. They should be responsible for research professions and feasibility discussion professions for the strategic development of the industry, professions for examining and accepting patents for technical inventions and innovations and scientific discoveries in the industry, and quota and directional information and consulting professions. Information networks should strive to become a reliable force in the information field for the industry and for the member units of the networks.

2. Every network should strive to become an integrated body with a real capacity for self-development in a competitive environment. They should independently or jointly develop a domestic information market for the scope of the industry, participate in technical circulation activities, independently or jointly manage information industries, take responsibility for information development projects and information consulting services entrusted to them by society, be capable of meeting society's needs for news and information, and become a reliable information industry for society. Through technical market activities, information networks continually expand domestic sources of information and supplement their own industry.

3. Every network should independently enter international information markets within the scope of state policies. They should participate in international technical market activities, dare to take on information research services and information consulting services for foreign plants and businesses, and strive to become a professional information industry with an international reputation. International activities both expand international sources of information and supplement our own information resource banks.

4. To achieve healthy development and be successful in competition, every network should select capable leading units and individuals. The leading units should take action to create the conditions and strive to provide themselves with the following conditions:

(1) Have domestic and foreign documentary information and small-scale material samples for all specializations and primary interrelated specializations in the industry to enable them to provide them for use by users in any form and in a timely fashion.

(2) Have domestic written, numerical and material data banks, and personnel banks for all specializations and related specializations within the industry and be able to provide various types of services for domestic and foreign users; have international on-line computer examination and search terminals and provide all types of services to users.

(3) Create reputable domestic as well as foreign publications like information periodicals and information bulletins which embody the characteristics of the industry, and have their own printing capabilities.

(4) Have professional information research forces and rather advanced part time or temporary information research staffs rationally matched to the personnel structures and intellectual structures within the range of the industry. In addition, there should be a group of backbone forces and leaders. They should have organizational and administrative capabilities, definite theoretical and policy standards, and be able to start with reality and implement party principles and policies. They should have a spirit of development and initiative and a factual scientific attitude, keen ideology, be good at reflection, and experienced in survey research, comprehensive analysis and actual work.

5. Work by each major profession to coordinate each of the specialized information networks in its system should gradually make the transition from administrative management forms to service management forms. The entire national defense scientific information system should have an authoritative mass coordination organization to assist the National Defense Science and Industry Commission Information Bureau in coordinating the development, construction and administrative activities of the entire system's information network, create the conditions for developing a domestic information network for each network, enter international information markets, participate in domestic and foreign technical exchange activities, and gradually form a national defense S&T information network development group.

6. Every network should strive to have development departments and marketing personnel in the relevant scientific research, education, design, and production units participate in network activities to form a multi-departmental, multilayer network system around the "leaders of" [core integrated organs] of information departments, and facilitate the development of integrated services.

## II. The Strategic Focus of National Defense S&T Information Networks

The focus of services in national defense S&T information networks is on providing forecast information guarantees to guide development and construction of the cause of national defense S&T, provide timely policymaking information guarantees, and provide dynamic information guarantees as needed. Given these prerequisites, they should develop all-encompassing services oriented toward society. The focus of strategic development and construction should be development of information markets and achieving commercialization, industrialization and socialization of information.

The focus of organizational coordination work should be to make the transition from administrative management and administrative cooperation to service administration and contractual responsibility.

## III. Strategic Measures for Development of National Defense S&T Information Networks

First of all, in the area of consciousness we must adapt to the environment of reforms before we can have a spirit of opening up and effectively explore reforms. The changes in consciousness include: establishing a competitive

consciousness, a managerial consciousness, a consciousness of "exploring unknown paths ourselves" and "finding our own vitality," and a consciousness of studying users and making users number one for positive action to serve users. There also must be conceptual changes. These conceptual changes include: the concept of commodities, the concept of markets, the concept of industries and the concept of socialization. This means that we must acknowledge that the information industry is an emerging industry, that information products are active commodities in the form of knowledge, and that they have value. We must take the initiative to open up information markets, actively dedicate ourselves to technical market activities, and take the road of socialization before we can invigorate information work. With changes in consciousness and concepts, we next must adopt the following measures before it will be possible for reforms in information systems to move forward.

1. To open up the situation of information network management activities as quickly as possible, we propose that a joint conference composed of officials from departments responsible for the organization and coordination of information networks in each major profession be established under the leadership of the National Defense Science and Industry Commission Information Bureau. On the one hand, it would be responsible for organizing exploration and study of paths for reforms in information networks, continually summarize fresh experiences during the reforms, and guide the development of reform. On the other hand, it would coordinate managerial activities in information networks to open up and create the conditions for administrative activities in the networks. This organ could engage independently in international contacts in accordance with the relevant state decisions.
2. Information network organization and management departments in every major industry should make a gradual transition from an administrative management form to a service management form. Besides gradually attaining surplus wages and basic welfare, they should become self-sufficient in organizational activity expenditures and award funds to invigorate all of the networks under their jurisdiction and adapt to the need for reforms in economic systems, S&T systems and information systems.
3. To assure that information networks have strong and effective reserve strengths, leading units in the networks should gradually migrate toward effective professional information development centers. To assure effective development of daily work in the information networks, administrative departments in every major professional information network can implement a subsidized labor recruitment assignment system to provide labor subsidies in the appropriate amount to the units under them. An income deduction subsidy system should be implemented for individuals engaged in information network organization work.
4. The professional incomes from information network management and information services should not be turned over to higher authorities for 3 years. They should be retained in their entirety by the networks as development funds, activity expenditures and welfare funds.



5. Whether one is speaking of directive tasks assigned by higher authorities to lower levels or of administrative tasks arriving from a horizontal direction, a bid contract system should be implemented for all of them, with remuneration by item and rewards and punishments implemented according to contractual stipulations.

6. To encourage information networks to explore new ground, find their own vitality, and move forward, regular administrative average subsidy systems should be eliminated and a system of investments focused on construction projects and contractual responsibility projects should be implemented, with the National Defense Science and Industry Commission Information Bureau controlling their utilization.

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**Solid Groundwork Said Key to Construction of High Tech Development Regions**

40080026 Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 4, Oct 87 pp 8-12

[Article by Gong Jinxing [7895 6855 2502] of the Scientific Research Management Research Office, Nanjing Branch, Chinese Academy of Sciences]

[Text] [Abstract] Development of high technology is the tide of the modern world. High tech is the "tap" of the technology system as a whole, and it is a focus of international economic, technological, and military competition. It is essential that high technology be developed in China and that we lay the groundwork in the areas of tracking research and developmental production as quickly as possible. We should select focal development regions on the basis of overall conditions, and we should conscientiously make good choices of key development realms and groundwork projects with good prospects, large results, and broad technical coverage. It is proposed that the relevant policies be readjusted to formulate preferential policy measures in areas such as loans, taxation, risk capital, distribution of benefits, concurrent positions, personnel circulation, and so on.

I.

High tech developed quickly in many nations of the world after World War II and its constant changes have created guiding influences which have attracted worldwide attention. Several high tech development zones formed in certain countries and regions during this process, and they now number about 200. They have not only provided models for the development of new industries but also caused profound changes in social structure and management systems, and they have created a new direction in urban development.

High tech is the "tap" of the technology system as a whole. Standards and advantages in this area are indicative to a substantial extent of a nation's economic might. In international relations, competition in the

realm of high tech has become the focus of competition in the economic, technical, and military preparedness realms. This trend makes it essential that China develop high tech. Whether we are speaking of the modernization of industry, agriculture, communications and transportation, national defense, or S&T themselves, all urgently require the impetus of high tech. This is a global tide of history.

The range of the impetus of high tech in the economy and technology is very large. The technical coverage rate in more than 40 key industries in microcomputer technologies is almost 100 percent. In other areas like raw materials, laser technologies, bioengineering technologies, and so on, the technical coverage rate exceeds 30 percent and is as high as about 50 percent in some of them. From one perspective, this technical coverage rate reflects the identity between high tech development and transformation of traditional industries. Medium- and long-term development of the Chinese economy will be affected greatly by the presence or absence of a focus on high tech development. The ability of China's enterprises to derive sufficient "reserve strength" for development will be determined to a very great extent by progress in high tech development and very good integration of high tech development with traditional industries.

However, high tech development includes stronger research, striving to track advanced international levels, and actively developing transfer products. This requires formation of a clear guiding ideology, principles, and policies in policymaking departments since policy mistakes can create enormous waste. If we hesitate to decide major questions, however, we also may miss an opportunity and push China into a backward and passive position in this area.

After Comrade Zhao Ziyang proposed that we meet the "challenge" of the new technical revolution in October 1983, everyone's understanding of high tech development was raised substantially. The state now treats development of S&T as a strategic focus and has formulated several policies and measures. In recent years, it also deployed tracking type research work in the high tech realm. However, high tech development still has not received widespread attention and understandings vary. For example:

Some feel that high tech development and establishing new industries costs too much, is very difficult, involves great risks, and would not be as good as selecting projects which produce high profits and taxes, and which have stable, high output to provide "fast-acting" investments. Some regions blindly built more than 10 distilleries in the past few years for precisely this reason.

Some feel that China has few mature technologies it can develop itself and that renovated products and technologies are required, which is not the same as importing complete sets of advanced equipment. This sort of

rapid result would enable reductions in the disparity between products and international standards.

Some go so far as to point out that state investments are needed to develop high tech. Without large amounts of financial appropriations and planned investments, it would be best to wait.

In the final analysis, all these ideas indicate an inadequate understanding of the development of high tech as well as a lack of determination and steps taken.

In reality, the ideology of inertia in this area is without foundation. We can analyze the necessity and feasibility of high tech development in China in the following areas.

First, the scope of high tech is extremely broad and scientific disciplines are expanding continually, so no one nation can stand at the forefront in all areas. The United States, of course, has many overall advantages, but the high wages paid to labor and expensive products mean that technical renewal has a tendency to stagnate gradually, and breaches in technologies and technical quality continually appear. A reversal began in 1984 in foreign trade involving electronic products. France, on the other hand, has advantages in the area of nuclear technologies, West Germany has certain advantages in precision automated devices and instruments, and Japan has an edge in civilian and household electronic products. As a result, competition in the high tech realm now is forming an interlocking situation. Even third world nations like Singapore, South Korea, and other countries are working feverishly to catch up with certain high tech product realms. If each realm and branch of high tech is illustrated on a tree chart, it is apparent that the "hot points" and shortcomings among them are continually changing. Pathbreaking breakthroughs in research on superconductors in recent years are clear confirmations of this. China of course cannot catch up in every area in the medium and short term, but we can lay a stable foundation, find avenues in certain realms of possibility, and form local advantages.

Second, imports are necessary since they can promote new technologies in China and the beginning and development of new industries if done well. The central point, however, is the eventual formation of our own "fist" [advantages]. Foreigners cannot sell the newest technologies to China. Generally speaking, they provide us with things that are one or two generations, 5 to 10 years, behind the newest technologies. If we rely entirely on imports of complete sets of equipment, we will remain in a passive, dependent, and backward state for a long time. As a result, major efforts to reinforce our own research and development strengths, and a focus on absorbing, digesting, improving, and innovation are required to achieve an active situation and obtain better results in the economic realm.

Third, the problem is not that China lacks forces. According to our statistics for a CPC Committee in a certain province, more than 10,000 people are involved in high tech research and development. Estimates are that China has nearly 200,000 specialized personnel (at the assistant professor and research study personnel levels and above) in this field who make thousands of achievements each year. If these personnel, finances, materials, and achievements are integrated with analysis, digestion, development, and innovation of imported technologies for technical transformation in industrial departments, the benefits would be considerable.

Fourth, China certainly is not wealthy and it has capital shortages, but a large nation with a population of 1 billion also has many sources of finances and all of them combined would make quite a sum. Capital can be raised for other activities, so why not high tech?

Fifth, there are definite risks involved in high tech development. If we fear risks, we will be unable to have high tech and new industries. Sitting on the bank and maintaining a single system in the area of products and technologies for decades cannot continue.

## II.

It would seem that China lacks the conditions for major efforts to develop high tech, but we cannot fail to do so. Given objective trends and subjective forces, the most urgent task is to lay the groundwork.

The first problem in laying the groundwork is to choose key realms for high tech development. Preliminary work is underway, but it will take 10 to 20 years before special zones at a definite scale take shape. Moreover, the key realms of high tech development of course have their own developmental laws and special requirements. Thus, they must be selected carefully as soon as possible.

The concept of high tech includes not only technology itself but usually products as well. These technologies and products are characterized by a fast pace of renewal and short development periods. Microcomputers are an example. Usually, a new generation of products appears every 4 or 5 years. This is different from traditional industries and traditional technologies, which maintain loose but continuous ties. A transferred technology usually can be sustained for 5 years or 8 years without tracking and support. High tech, on the other hand, requires closer integration of technical research and production, and research units and producing enterprises have an even closer relationship. As a result, to improve communications conditions, the geographical separation cannot be too great. Besides this, education and training work also must keep pace at all times. Such special requirements are the intrinsic reason behind the continual appearance of various "science and industry parks," "science parks," "high tech development regions," "science cities," and so on. Structurally speaking, they must form a

unified system of scientific research-education-production according to special requirements. In western nations, these development regions or parks often are centered around one or more strong core comprehensive industrial and technical universities. In the United States, for example, a high tech development region has formed around the Massachusetts Institute of Technology and the reason is that MIT is a famous comprehensive technological university. The technical advantages and continually emergence of new research achievements which take shape in this sort of educational and research organ continually spawn new industries and give them sustained technical "reserve strengths" and vitality in the area of product competition.

High tech development has a very strong synthetic quality in the area of technology. Usually, it is not sufficient to focus merely on one or a few technologies but instead requires synthetic tracking and support of technologies in many realms. Technical forces in new industries must be greatly reinforced, in some cases reaching 30 to 40 percent of all enterprise employees. They cannot substitute, however, for the role of universities and major independent research organs and still require support from a community of development regions.

Another requirement in selection of development regions is that they must depend on a foundation of excellent basic urban facilities. The reason is that these small regions have their own local characteristics both in terms of technology and industrial economics. They do not have to be nor can they be built into completely independent urban deployments, especially during the initial development stage. They must be near major cities to be able to make full use of urban facilities in aviation, railways, ports, inner-city public transportation, power supplies, water supplies, gas supplies, education, commercial networks, medicine and public health, tourism, entertainment, sports, and other facilities, as well as banking, taxation, legal, consulting services, and other conditions.

However, high tech development regions also have their own special requirements. The development of high precision incisive products requires the installation and utilization of a whole series of highly precise, highly sensitive experimental and testing instruments and equipment. This requires a rather good environment, pure air and water, and a temperate climate. In addition, communications equipment and capabilities in such a region as well as the quality of service facilities all should be superior to levels in existing urban areas to meet the special needs for quickness, conservation, and effectiveness of these technologies and industries.

In summary, there should be good site selection work for the important component parts of the groundwork for high tech. This is the main aspect of optimal investment conditions. If an inappropriate site is selected, people will not be willing to make investments or they will be



forced to do so by administrative decree, and there will be no end to future problems.

Optimal site selection depends on comprehensive consideration and evaluation of a variety of factors. Policy decisions cannot be made based on a single factor. For example, they cannot be based entirely on the administrative level of a city, nor can we simply take note of the absolute number of S&T personnel, and even less can we begin wrangling again because of a struggle over focal points and investments or because of personal pleas and connections.

The author feels that the selection of high tech development regions should involve comprehensive consideration of the following factors: 1) The overall intellectual foundation and technical strengths of a city; 2) the quality and quantity of specialized forces in high tech fields; 3) the level and strength of comprehensive processing in technology-intensive enterprises related to high tech; 4) the environmental conditions of existing candidate sites and their distance from urban technology-intensive sites; 5) the level and capacity of urban transportation and communications facilities; 6) the quality of the urban environment and natural conditions, including water resources and climate; 7) the geographical position of the city; 8) the basic living conditions of personnel; 9) basic educational facilities and conditions; and 10) the conditions of cultural, educational, entertainment, and other types of facilities.

Selection of an optimum development region is possible if these factors are analyzed comprehensively and different candidate sites are compared, and after full debate. Policymaking in this manner will have major benefits for medium- and long-term construction in China. Forced selections made because of single factor in the absence of debate inevitably will create enormous losses. For this reason, we should start now to organize the forces for the related survey research and debate.

### III.

One important aspect of groundwork for high tech development regions is the selection of focal realms and key projects. This is difficult work. A good war depends on the first battle. Initial defeat would lead to passivity, but victory in the first battle would embolden everyone. Although risk capital is needed for high tech development, policy decisions should stress reducing the number of risks and increasing the success rate.

China's high tech research (not referring to tracking research) has only been underway for 3 or 4 years. Because of historical factors and systemic factors, technical experts in China generally have an inadequate understanding of technical economic value and market reactions, and their research in the area of high tech also is rather

weak. Regional research which integrates high tech and new industries is even less adequate. Doing so might create unsolvable problems with coordinated development of major projects and coordinated processing, and the outcome of development would not be ideal. Some new enterprises have required considerable investments, but only the good communications and scenic conditions were taken into consideration and they were hurriedly constructed. Because they lacked effective research forces for backup support to high tech, the commodities produced using imported equipment soon became outdated and lacked market competitiveness, so the whole enterprise ended up in dire straits.

It is apparent from this that the development of high tech (referring mainly to development and production) urgently requires the selection of an optimum groundwork project to serve as a focal development region. This demands good policy research on key development region projects. One prerequisite is a clear understanding of systems of indices for evaluating them.

Generally speaking, decisions on production in high tech development projects must be made after intermediate testing and before expanded testing and design for manufacture. The reason is that intermediate testing is the determining link in confirming the maturity of a technology.

Among the many high tech research achievements, opinions vary concerning which projects should be selected first and which areas to choose for breakthroughs, and there also are different methods. Some technical experts are particularly fond of first considering the degree of lead in a technology in China or the degree of lead internationally, and they are concerned mainly with "new" and "advanced." Entrepreneurs and economic management departments, however, focus on market prospects and economic benefits, especially profit and tax rates. They hope to derive returns to their investments through mass production and quick turnaround. The degree of lead in a technology depends on production conditions, market conditions, and expected results. If decisions are based on this understanding, the degree of technical lead in a development project is not certain to be the highest.

We feel that of course we should engage in development and putting them into production. The problem, then, enters the economic realm and expands beyond the realm of simple research. It requires that we first of all observe the conditions of cooperative production, investment schedules, economic benefits, market demand, size of investments, extent to which the products are produced within China, and so on. In addition, we should consider the degree of technical lead. Multifactoral comprehensive analysis of projects would enable correct policy decisions.

Moreover, the basic level of enterprises means that their limited status often causes them to place more emphasis on the direct benefits of

production to the neglect of the indirect benefits and social benefits of their products in the technical economic realm. Thus, administrative departments and soft experts must participate in the research if problems in this area are to be solved well. For example, besides the income from sales for production of various microcomputer components or assemblies, they also can be installed in the machine industry, chemical industry, light industry, and other sectors for the production of many new automated, electronic, and numerically controlled products. The value of a numerically controlled machine tool is many times greater than a conventional machine tool. Therefore, when selecting optimum investment projects, forecasts should be made of the products and degree of technical coverage, and every effort should be made at realistic evaluation and estimation of their indirect benefits.

Only correct selection of groundwork projects will permit successful cooperation and development, and only then will it be possible to make progress in construction of high tech development regions. When they can begin mass production, even if they are incapable of competing on international markets, they will at least fill in a blank space within China, and they will promote domestic production of new technical products, save large amounts of foreign exchange, improve the processing matchup capacity and technical levels, improve the quality of processing staffs, and thereafter gradually raise the grade of the products, substitute them for the previous generation, and enter international markets. In this way, all high tech development regions could gain vitality gradually.

#### IV.

Another aspect of the groundwork is to study and formulate the relevant concrete policies to promote smooth high tech development. China has adopted a policy of tax exemptions and reductions for new technical products for specific periods of time, and the results have been rather good. Loans for investments in trial development of new products, technical transformation, and other purposes also are quite necessary. However, these policies alone are not sufficient to guarantee smooth progress in high tech development.

The high tech realm is characterized by large results, big investments, rapid renewal, broad-based cooperation in production, and other things. High tech requires bilateral cooperation between scientific research and production, so it inevitably concerns questions of technical investments, land shares, responsibility for the riskiness of capital inputs, and so on. In addition, there is the question of coordinative relationships among enterprises involving the producers of the primary machinery (the ultimate product) and component producers. The relationships among the investors in development regions also concerns questions of responsibilities, rights, and interests between central authorities and provinces and the cities in which they are located. If these relationships are clarified and policy stipulations are made



concerning the question of principle involved, we can overcome the contradictions created by separation and promote coordinated development. If we accept that other realms require the impetus of new systems and policies, they are even more important for the realm of high tech development. Because high tech is a completely new and even higher force of production, it of course requires the formation of new and more perfect productive relationships. To date, "risk capital" has not been mentioned in financial affairs items or fiscal headings. This shortcoming should be corrected as quickly as possible.

In addition, because of the special requirements of high tech, a solution to questions of S&T personnel circulation and concurrent positions is especially urgent. During the prime of his life, the "Father of Silicon Valley," Professor (Teman), Vice President of Stanford University in the United States, made historical contributions to the formation of Silicon Valley. The main role he played was to allow and assist young scientists and technicians at Stanford to go into business, run enterprises or work concurrently in enterprises. The importance of personnel policies on high tech development is apparent. Generally speaking, because they require special working conditions and support for interdisciplinary circulation, most people in the backbone high tech force working in high tech and research institutes imports are unable to leave their former jobs and take jobs in enterprises. The only ones who can be transferred to enterprises are a small number of middle-aged and young people. What high tech development needs, however, is tracking technical support, not occasional and temporary consulting. This sort of tracking support cannot depend solely on the spare time of S&T personnel. In addition, S&T personnel in enterprises should be selected for refresher courses or training in institutions of higher education and research institutes. Only by formulating truly feasible policies for personnel circulation quickly will it be possible to achieve healthy growth of coordinated development.

We propose that the State Economic Commission and S&T management departments should personally organize and assign several topical research tasks for feasibility research on policy questions related to high tech development. If we do this groundwork well, the flowers of high tech certainly will be able to come to fruition in China.

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## CAS Survey on Impact of S&amp;T System Reforms on Research Institutes

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[Article by Zhou Chengkui [0719 2052 1145], Sun Yulin [1327 3768 7792], and Lian Yanhua [6647 3601 5478] of the Science and Technology Policy and Management Science Institute, Chinese Academy of Sciences [Footnote] [Members of the topical group also included Chen Renpeng [7115 0086 7720] and Wu Yingxi [0702 5391 3556] of the Shanghai Branch, CAS]: "Short-Term Effects of S&T System Reforms on Research Institutes (Survey Report)"]

[Text] One of the primary long-term shortcomings in China's S&T and economic systems is the detachment of S&T work from production and development which has forestalled adaptation to the attainment of China's economic goals for the end of the 20th Century and an economic takeoff in the early 21st Century. The CPC Central Committee has pointed out that economic development depends both on policies and on S&T. The success or failure of S&T system reforms not only affects the development of S&T themselves but also is related directly to the growth of economic construction. Intensive research on the theoretical and practical aspects of S&T system reforms thus is very important.

The shift from administrative scientific research funding to an appropriation method in recent years as well as a series of reform measures such as opening technology markets, encouraging personnel circulation, and so on, have promoted integration between scientific research organs and producing enterprises, and have accelerated the transfer of technologies to productive uses. China's S&T system reforms, however, were made in a situation of inadequate theoretical and practical preparation. The external environment of the reforms, which includes enterprise vitality, the investment environment, the social conditions of personnel circulation, state administrative and managerial systems, and so on, has not been extremely favorable or coordinated. Moreover, gross social demand in excess of gross social supply and

capital shortages will continue to exist for some time and create long-term problems for technical progress in enterprises. Thus, many factors restrict S&T system reforms. We must take the lead in reforms in economic systems and political systems, and must progress independently; thus reforms would seem to be quite difficult. However, S&T system reforms also are dynamic, and should be interdependent on and conditional to economic and political system reforms. We cannot await invigoration of enterprises and formation of an external environment to begin S&T system reforms.

During 1986, we spent more than half a year assisted by relevant departments in Shanghai Municipality, Tianjin Municipality, Jiangsu Province, Zhejiang Province, Hunan Province, and the Chinese Academy of Sciences [CAS] to make a sample survey of 274 independent research institutes and their directors and 1,396 S&T personnel concerning S&T system reforms. Divided according to jurisdictional relationships, these 274 research institutes included 37 in the CAS, 52 under jurisdiction of State Council departments, and 185 under provincial and municipal jurisdiction (including research institutes run by provincial and municipal offices and bureaus). The 1,396 S&T personnel surveyed included 179 advanced research S&T personnel, or 13 percent, 814 mid-level research and S&T personnel, equal to 58 percent, 299 lower-level research and S&T personnel, equal to 21 percent, and 98 other personnel, equal to 7 percent.

All of the data collected in the survey was entered into computers for numerical processing and classification by categories. The sampling was done in strict accordance with scientific sampling methods and is quite representative.

While carrying out the questionnaire survey, we also made a model survey of some research institutes in Shanghai, Zhejiang, Jiangsu, and the CAS, and we made on-site inspections of township and town enterprises in southern Jiangsu where we obtained much first-hand data. We also requested that the relevant departments make a special survey of independent research institutes supported by Shanghai and Tianjin municipalities, of township and town enterprises in Wenzhou and southern Jiangsu, and of key research institutes under some industrial departments.

Afterwards, we convened two topical discussion meetings in October 1986 and April 1987. Besides the numbers in the topical group, participants in the meetings included comrades who had participated for long periods in S&T policy and management work from the science commissions of Zhejiang Province, Hunan Province, Shanghai Municipality, and Tianjin Municipality, from the Nanjing Branch of the CAS and so on. The meetings involved an intensive exchange of opinions on certain issues.

The research report took shape on the basis of these surveys and discussions. Published here is an outline and key points.

## 1. Scientific Research Topic Selection and Funding Structures

1. The basic goal of S&T system reforms in China in recent years has been to strengthen the integration of scientific research with production. Several reform measures have been adopted in areas such as S&T operational mechanisms, organizational structures, personnel systems, and so on. Preliminary progress has been made and a good momentum has appeared in the orientation of S&T toward economic construction. This was especially true beginning in 1984 of the emphasis on independent funding for development-oriented research institutes which extended to March 1985, when the CPC Central Committee issued a formal proposal in its decisions on S&T system reforms which called for a transition to an appropriation method for scientific research expenditures and reinforced the motives for research institutes to "orient toward economic construction."

First of all, changes began occurring in the motives for scientific research topic selection in research institutes. According to a questionnaire survey of sample units, the original principle in applied research and technical development of "needed by production units" rose from the pre-reform levels of eighth and third place, respectively, to first place, followed by "ease of obtaining research funds" and "included among state tasks." The "opinion of administrative departments" was second only to "included among state tasks" in influence on selection of research topics before the reforms, but has fallen to seventh and sixth place, respectively, since the reforms. Least influential in topic selection were "whether or not it was at the forefront of international S&T development," "opinions of leading figures in other fields," and "effects on social public opinion." It is apparent that market signals are playing a role in the selection of scientific research topics while the role of administrative departments is being weakened. The fact that "whether or not it was easy to obtain research funds" held second place shows the power of economic measures, but it also draws our attention. If reforms in appropriation systems are not coordinated, it would be easy to fall into a situation in which only money-making topics are chosen, which in turn would have negative influences on the development of S&T.

2. Changes in factors affecting topic selection are confirmed by changes in the structure of topics at research institutes. According to statistics for 37 sample CAS units for the 5-year period from 1982 to 1986, there was a tendency for growth in horizontal topics assigned directly by enterprises, departments, and local areas. Topics assigned by enterprises increased from 1 percent to 5 percent of all topics. Topics assigned by departments and local areas rose from 7 to 15 percent. In the area of vertical topics, the number of state-assigned topics for attacks on key S&T problems has held basically stable at around 12 percent since 1983. After peaking at 26 percent in 1983, the proportion of research topics assigned by primary administrative departments and organizations fell slightly each year until 1986, when

it dropped abruptly to 14 percent. The greatest decrease, however, was in the number of topics chosen by S&T personnel themselves. These topics accounted for 63 percent of all topics in 1982 but only 29 percent in 1985, a decline of 34 percent. Of course, funding support for some of the self-selected topics is available by applying to the Natural Science Fund, but self-selected topics and science fund topics are intermixed, and there was a 20 percent decrease between 1982 and 1985.

3. Changes in the structure of topics have been accompanied by changes in the structure of supplies of scientific research funds in research institutes. A survey of 266 sample units showed that the proportion of scientific research expenditures which came from departments, local areas, and enterprises as well as achievement transfers, consulting services, and other horizontal income increased from 17.7 percent in 1983 to 29 percent in 1985. The proportion receiving assistance from key state project funds and administrative department project appropriations increased from 22.7 percent in 1983 to 27.2 percent in 1985. However, the proportion of state operating expenses declined from 59.6 percent to 43.9 percent (income from sales of technical products were not included when calculating the supply structure of research institute scientific research funds).

4. During the 3-year period from 1983 to 1985, vertical financial appropriations from operating expense appropriations, funds to assist attacks on key S&T problems, financial assistance from administrative departments, and so on, grew at an average yearly rate of 4.6 percent. In addition, horizontal income from enterprises, departments, and local areas and from achievement transfers, consulting services, and so on, increased at an average yearly rate of 43.3 percent, while the volume of sales of technical products increased at an average yearly rate of 33.3 percent, and other income increased at an average yearly rate of 41.7 percent.

Although expenditures have increased in research institutes, a common sentiment is that they have a shortage of funds for scientific research. Of the 1,396 scientific research personnel in the sample units, 68.4 percent felt that shortages in scientific research expenditures would continue to grow. Only 12.9 percent felt that there were sufficient expenditures.

Several interrelated factors play a role in the appearance of the phenomenon of increased funds coexisting with shortages. In the area of capital supplies, the first thing is a lack of matchup between tasks and the corresponding capital inputs. Statistics from a survey of 995 S&T personnel who felt that expenditure problems were becoming a bigger problem showed that 57.9 percent of them felt that funds for vertically-assigned tasks were insufficient, while 49.2 percent felt that funds provided by departments, local areas, and enterprises were insufficient. The second thing is that research institutes often are not included in



technology transfers. A survey of 144 successfully transferred scientific research achievements showed that expenditures on technical patents for 74 items or 51.4 percent of the sample were less than the scientific research expenditures used directly for project research. In the area of fund utilization, there has been a tendency in recent years for inputs from things other than scientific research to rise. This, added to the readjustments in foreign exchange price ratios, rising material prices, and the increases in the various processing and labor costs in scientific research which they engender, has seriously affected the effective utilization of funds.

## II. Technology Transfers and Enterprise Vitality

5. One of the main criteria for evaluating S&T system reforms in China is whether or not the transfer of scientific research achievements from the laboratory to producing enterprises has been speeded up. The scale of technology transfers in China has expanded every year over the past few years and the rate has risen every year. Among the 274 units in the sample, 224 or 81.7 percent made technology transfers between 1983 and 1985. These 224 research organs transferred 1,011 scientific research achievements to producing enterprises in 1983. They transferred 1,574 items in 1984, up 55.7 percent over 1983, and 2,178 items in 1985, up 38.4 percent over 1984.

The economic benefits arising from these technology transfers are obvious. A survey of 80 successful technology transfers showed that they increased the value of output in enterprises by 205.068 million yuan. They paid 26.5 million yuan in taxes and retained 12.58 million yuan in enterprise profits. Technical patent fees paid to research institutes totalled 2.827 million yuan, equal to 7.2 percent of plant profits.

The main reason for successful technology transfers in the sample units over the past few years was the good technical and economic feasibility of the scientific research achievements. Market sales avenues existed after the products were developed and enterprises could earn profits. The other factors, in order, were: the scientific research topics chosen by the research institutes could be integrated with production; the research institutes strengthened technical development and extension of achievements; and the enterprises had technical requirements motivated by innovation and profit. It deserves mention that a closer relationship between plants and research institutes was important in the technology transfers.

6. In the area of channels for technology transfers, activities by various types of intermediate organizations, technical trade fairs, exhibitions, transfers of technologies via the circulation of S&T personnel, and other things have begun to develop. In a 3-year period from 1983 to 1985, the scientific research achievements transferred in this manner by the sample units accounted for 9.6 percent of all

achievements transferred. At present, however, the primary channel for transfers of scientific research achievements to enterprises continues to be that research institutes take the initiative to extend them and enterprises come to purchase them. The achievements transferred via these two channels accounted for 78 percent. Moreover, because administrative departments have focused on demand information and guaranteed supplies of capital, materials, and other factors of production, and because they influence enterprise development and other things, they continue to play an important role. As a result, administrative departments are rather important in the process of transferring major achievements. In 3 years, 12.4 percent of scientific research achievement made by the units in the sample were extended via administrative department arrangements. This shows that given a situation of continued underdevelopment of market mechanisms in China at the present time and the dual reliance of enterprises on markets and administrative departments, we should continue to pay extremely close attention to the organizational role of administrative departments in technology transfers.

7. Research institutes encountered many difficulties during the technology transfers, one of them being insufficient enterprise vitality. The research institutes have come to feel over the past few years that there has been an increase in topics assigned horizontally and that the situation in transfers of scientific research achievements to enterprises has improved each year, which indicates that the vitality of enterprise reliance on S&T has increased over the years. However, the research institutes felt very strongly that enterprise vitality was far from sufficient and that there was a great deal of imbalance. It was manifested in technical requirements, which were obviously higher in township and town enterprises than in large enterprises, and the large enterprises had a severe lack of strong technical demands deriving from a desire to expand profits. The Shanghai Branch of the CAS, located in a region of China where large and medium-sized enterprises are concentrated, has rather high scientific research standards. Among the recipients of achievement contracts signed in 1985, however, 30.9 percent were medium and small enterprises, 21.6 percent were township and town enterprises, 21.0 percent were scientific research units, 8.1 percent were institutions of higher education, 0.8 percent were foreign plants and businesses, and 4.1 percent were other targets, but only 1.4 percent were large enterprises. This lack of vitality concerning technical requirements in large enterprises is first of all due to the fact that they have too little independence in administration and policymaking and too excessive direct state plan controls over enterprise operations, which have given them insufficient competitive power. In addition, the level of profit retention in these enterprises is too low. The rate of enterprise profit retention has been around 30 percent for the past few years, but higher materials prices and additional social responsibilities of various sorts actually have meant that less capital is available for technical progress and enterprise development.



Although medium and small enterprises and township and town enterprises have greater independence following reforms in economic systems and the state has given them certain preferential treatment in the area of taxes, there still are restrictions over their finances. Their capital now does not depend mainly on their own funds but instead depends on bank loans. Thus, in a situation of an overheated economy and the issuance of large numbers of bank loans during the first half of 1985, the vitality of these enterprises was extremely stimulated and they were active as technology buyers in technical markets, leading to temporary prosperity on technology markets during the first half of 1985. As money supplies grew tighter and bank credit restrictions became more rigid, however, the very fragile vitality of these enterprises was affected. Thus, after technical markets had flourished temporarily in the first half of 1985, a tendency toward shrinkage appeared in the last half of 1985, and instances of enterprises scrapping or terminating contracts were common. As a result, there was an obvious drop in horizontal income in most research institutes during 1986. The sample survey showed that the extent of the decline ranged from 15 to 40 percent.

This situation shows that whether we are speaking of large enterprises or medium and small enterprises and township and town enterprises, the capital problem is the main factor which affects the vitality of their technical requirements. The survey of 80 plants and 144 research institutes also showed that 57.5 percent of the plants and 49 percent of the research institutes considered the enterprise capital shortage to be the main factor restricting technology transfers. Only 8.7 percent of 57 cooperative projects between the Shanghai Branch of the CAS and the Shanghai Petrochemical Plant were actually implemented. Moreover, of the 52 projects which could not be implemented, 69.2 percent were due to the plant's inability to provide research funds. Shanghai's 19 independently-funded research institutes terminated 57 percent of their horizontal contracts due to a lack of enterprise capital. It would appear that it is hard for technology alone to be converted into economic results. Technology must be linked with capital before it can produce new added value of capital. For this reason, pushing China's banking circles into the process of technology transfers to create more ways for enterprises and research institutes to raise capital has become an urgent question that must be considered during 6ST system reforms.

8. Another problem encountered by research institutes during technology transfers concerns reinforcement of the intermediate links in technology transfers. For a long time, the intermediate links between laboratory achievement and actual market value, which include engineering design, product design, intermediate testing, expanded testing, and so on, consistently have been the weakest links in the technology transfer chain. On the one hand, the extremely weak R&D capabilities in enterprises has meant that they have been unable to complete their part of the work in turning laboratory achievements into finished products. On the other hand, research institutes have been unable to turn all of

their useful achievements into production technologies or product prototypes which can be used directly by enterprises. Moreover, the prototype stage and the completeness of the technologies themselves are rather weak. Making this step, however, and finding ways to help enterprises transform their existing production technologies and production procedures remain the "short legs" of research institutes. For this reason, enterprises have gotten about 46.1 percent of their technologies through development within the enterprises themselves and transfers from similar enterprises, and 13.6 percent directly through imports of complete technologies or production lines from foreign countries. Only 37.5 percent were actually transferred from scientific research organs within China. Of this portion of the transferred technologies, two-thirds actually were products embodying technologies which enterprises purchased from research institutes. "Software" technologies transferred from research institutes to enterprises accounted for slightly more than 10 percent of enterprise technology sources. Weak intermediate links and this sort of "bottleneck effect" in technology transfers are major causes of many useful scientific research achievements being long-term "exhibits, gifts, and samples" which cannot actually be used in production. Therefore, strengthening intermediate links in technology transfers is another important aspect that should be considered for the next step in S&T system reforms.

### III. Some Problems Requiring Consideration

9. A common problem which has appeared in recent years is the decentralization and "lightening" [qingxinghua--6535 0992 0553--shift of focus from heavy industry to light industry] of scientific research topics. This is particularly true of CAS research institutes engaged in applied and developmental research and of "high-level" comprehensive research organizations, which should receive sufficient attention. In the CAS, for example, among the 1,606 scientific research achievements completed by the 122 CAS research institutes during 1985, the research schedule required less than 1 year for 35.8 percent of the achievements, 10.1 percent could be completed by a single person, and 29.5 percent required capital inputs of less than 10,000 yuan. A survey of Shanghai Municipality's 19 independently-funded research institutes showed that vertical research topics which were extremely difficult, required large investments, and had a broad range of applications declined by 7.7 percent between 1983 and 1985. The number of exploratory pre-research topics based on growth in market demand in 1985 was 8.3 percent less than in 1983.

One of the reasons behind this is an increasingly apparent situation of "too many monks and meager gruel" in scientific research expenditures. Moreover, increasing numbers of advanced and mid-level research personnel making requests for topics and enterprises centralizing capital to support a small number of scientific research topics may create a situation in which a large number of S&T personnel are "unemployed on the job," which in turn would pose a major threat of

internal instability in scientific research organs. As a result, this method becomes quite difficult in practice, so the only way out is to "sprinkle some pepper around." The second reason is that the proportion of topics assigned by local areas and enterprises has increased, but the enterprises which research institutes presently are accepting tasks from are mainly medium and small enterprises and township and town enterprises. These enterprises, however, are limited by capital, technical strengths, and stage of development. The levels of technical requirements generally are rather low and the scope of topics also is rather small. A third reason is that the proportion of topics receiving assistance from the Science Fund has increased, while the strength of funding assistance has been rather weak in most cases. A fourth reason is that after the shift was made to an appropriation method for scientific research fund, research institutes began to focus on the objective situation of current market demand in China to select more feasible methods for accumulating scientific research funds, meaning that they engage in "short, smooth, fast" projects which "earn money" quickly. A fifth reason is that current policies regarding promotion in professional positions, awards for achievements, and other things have led to problems of S&T personnel undertaking topics in a decentralized manner.

10. Inflation in inputs not related to scientific research and shrinkage in scientific research inputs is another problem which has appeared in the research institutes over the past few years. If we assume that research institute expenditures and income have a positive relationship with the direction of expenditures, then this situation also can be seen in the structure of expenditures and income of Shanghai's 19 independently-funded research institutes. Only 19.1 percent of the income in these research institutes actually came from scientific research, while their income from things other than scientific research was as high as 80.9 percent. Among the entire group of 266 units in the survey, income from things other than scientific research was 1.3 times scientific research income in 1985.

The inflation of inputs for things other than scientific research and shrinkage of scientific research inputs continues to exist. The appearance of this situation is related to the vagaries of prices for technologies and technical products: no one "knows what's what" regarding technologies and they cannot be sold for a good price. Research institutes also want to gradually achieve partial or complete funding independence. One choice they have is to build their own plants to make the products. The result of this method, however, is first that the institutes themselves may be endangered since continuing to do so for any period of time would make it very hard for them to have any real significance as research institutes. Moreover, the shrinkage in scientific research inputs directly endangers scientific creativity and we could very quickly face a serious situation in which sources of knowledge and technology dry up. Also, with the exception of some high-tech products which must be developed in research institutes, the fact

that production in a research institute never reaches optimum scale in traditional industry capacities means that from a macroeconomic perspective, it would objectively accelerate the increasingly serious trend toward decentralization of investments and reduce economic benefits to society. This is a new problem which is not conducive to long-term development.

11. A substantial weakening of the spirit of coordination and integration in the S&T realm is a third problem which has appeared in research institutes in the past few years. The survey of 1,396 S&T personnel showed that 66.5 percent felt that the spirit of cooperation between units was becoming weaker and 34.8 percent felt that the spirit of cooperation on topics was being weakened. This sentiment was even more apparent among S&T personnel in the CAS. This is an extremely serious situation. It would seem that completing major and comprehensive S&T tasks, being capable of competing with foreign countries, and being able to achieve the optimal utilization of scientific research input factors (manpower, finances, materials) requires that administrative measures and the corresponding policies be adopted to promote integration on a high-tech and substantial foundation in the areas of application and development projects. Of course, this would require that other scientific research work be deregulated to encourage and promote competition among research institutes. This in turn makes rational utilization and mutual technical supplementation of resources even more important for projects and goals which require integration. Thus, when selecting a target for integration, we also should encourage an appropriate degree of competition.

12. A fourth problem encountered by many research institutes when seeking increased horizontal economic income is technical secrecy and blind patenting of technologies. Some research institutes have been unwilling to give patents to producing enterprises for some technologies which are not very technically complicated and have high added technical value after being turned into products and with rather large markets, but they are willing to organize production themselves. Because production in research institutes often fails to attain an economic scale however, it is very possible that they would not be capable of increasing overall economic benefits to society as a whole. Technologies for which production is hard to organize by research institutes also often serves as a technical "reserve" which can never be developed into a finished product because they are unwilling to extend it. This obstructs the extension and application of technical achievements. For technologies whose patents are transferred outside, some research institutes control the key technologies, directions, and materials, or they may transfer a patent for production technologies for a single product to several enterprises, which creates an irrational deployment of the regional economy. Although this situation is not extremely common at present, our model survey of all regions also indicated an obvious feeling that it is growing in some research institutes.

#### IV. A Discussion of Criteria for Evaluating S&T Systems and Research Institutes

13. The main criterion now used to evaluate S&T system reforms in China is integration of scientific research with production. This evaluative criterion undoubtedly is correct since the detachment of scientific research from production is a major long-term problem in China's S&T systems. Added to the fact that China has entered a period of socialist modernization and construction focused on economic construction, there is an urgent need to use scientific and technical progress to promote sustained economic growth. However, the single criterion of integration of scientific research with production for S&T system reforms is quite obviously insufficient. The social functions of science and technology are multifaceted. Besides promoting economic development, they also should promote culture, education, national defense, and the prosperity and progress of all of society. At the same time, we cannot forget the laws of development of S&T themselves. A perfect S&T system requires that we note its effects on economic growth, its ability or inability to promote sustained development of S&T, and whether or not it can achieve the goal of mutual supplementation.

14. Based on this fundamental concept, we carried out a questionnaire survey of the directors of 274 research institutes concerning criteria for evaluating S&T system reforms. After summarizing and processing the opinions of most of the research institute directors, we felt that the criteria used to evaluate S&T systems should include the following main points:

The first is high productivity. S&T system reforms should enable research institutes to make more achievements and produce more skilled personnel than in the past, and their achievements should be at higher levels and their personnel ever sharper. This undoubtedly is a necessary condition for good S&T systems and research institutes.

The second is circulation. This refers to research institutes in a good S&T system being able not only to make achievements continually but also to apply their achievements effectively in production or actual social life, and also to be able to absorb information effectively and readjust their S&T activities based on the need to develop production, the development of society, and scientific and technical progress.

The third is creativity. Creativity is the essence of S&T activities. It involves discovery and understanding of the unknown. If a research institute merely follows others and repeats their scientific research, it will lose its value as a research institute. If this situation becomes widespread, it would indicate fundamental defects in the system itself.

The fourth is multiple layers. A good S&T system generally can assure that there is a division of labor among different types of scientific



research strength and different levels so that work proceeds in a linked fashion. If everyone is mixed together chaotically, it is inevitable that some important levels of work will be left out while "collisions" among other levels of work will create an enormous waste of resources.

The fifth is stability. A good S&T system should assure relative stability of scientific research staffs and scientific research work. A system which has frequent and numerous policy changes certainly is not a good system. Moreover, the key to sustained relative stability is that policies concerning major questions must conform to a specific policymaking procedure.

The sixth is selectivity. Any high-level research institute which makes major contributions always can develop and grow under a good system. However, all research institutes with low standards and minimal contributions will eventually shrink and disappear. If an S&T system lacks this selective mechanism, good research institutes will be unable to develop and poor research institutes will not be eliminated, nor will such a system be a healthy one.

Because the quality of operation in S&T systems eventually is reflected in the operational situation in research institutes, these evaluation criteria also are suitable for evaluating institutes. Of course, research institutes at different levels and of different types have different requirements, so there should be a variety of evaluative criteria. Of course, the feasibility of these criteria should be examined during practice.

15. Naturally, a good S&T system cannot be built in a single day, nor can it be completed in one try. The problem is that it requires comprehensive consideration and efforts in this direction. In addition, a particular focus is necessary at any given time. Our present focus on the integration of scientific research with production is a correct method which conforms to reality. However, only by guaranteeing and promoting the healthy development of S&T is better service to economic construction possible. For this reason, emphasis on the goal of integrating S&T with production also requires that consideration be given to the compatibility of other goals, and we at least cannot abandon or damage the achievement of other goals.

#### Postscript

There are four additional parts to this article which involve a rather detailed examination of the good and bad aspects of independent decisionmaking rights in research institutes, implementation of an institute director responsibility system, encouragement of personnel circulation, implementation of a professional employee recruiting system, and other reform measures. Of the reform measures which have appeared so far, the research institute directors feel that expansion of

the decisionmaking rights of research institutes played the greatest role in promoting work in research institutes. One contradiction encountered during the implementation process, however, was a lack of coordination with current state administration systems. There still are limits on the decisionmaking authority of research institutes regarding hiring, promotions, rewards, and punishments and other areas. Funds available to research institutes also continue to decrease. At the same time, the lack of adaptation in the area of macroeconomic administration has permitted greater disorder in the operation of the S&T system as a whole. The relevant departments should work to formulate state and sectoral long-term plans and deployment plans as quickly as possible to prevent repetition and decentralization and strive for optimum economic benefits, and they should strengthen management over major projects and cultivation of a scientific research environment.

During the practical process of implementing an institute director responsibility system, the role of the institute directors has been strengthened and the efficiency of professional and administrative work has improved. However, 52 percent of the S&T personnel still feel that the institute director role is not being fully utilized, and 33.3 percent of the comrades felt that institute directors do not respect the opinions of S&T personnel. This is an indication of two prominent problems, referring to finding ways to make greater use of the role of institute directors and ways to perfect democratic management systems in research institutes. For this reason, clearly-specified terms and goals of responsibility must be formulated prior to an institute director taking office, and various types of democratic management must be established. There should be clear administrative and managerial procedures and an appropriate division of authority to attain the goals of democratic policymaking and mutual restriction. Major research institutes at the national level can try assigning tasks by administrative departments so that authority over strategic policy decisions is turned over to a management commission composed of colleagues and experts from throughout China and management personnel.

The actual progress made in encouraging personnel circulation over the past few years has not been ideal. The first problem is that not enough S&T personnel have circulated out of scientific research organs, and the second is that the direction of circulation is not rational. Most S&T personnel are unwilling to change jobs. Only 1 percent were truly willing to leave their scientific research organs. This is the result of objective influences as well as policy factors. In such a situation, various forms of concurrent job assignments have played a rather large role in promoting technical transfers, and they should be encouraged and advocated. There was a considerable difference of opinion concerning part-time concurrent appointments, with 61.3 percent of the institute directors having reservations. The main reason was the lack of a rational system of regulations to guarantee that normal work in research institutes is not affected and that technical and economic interests are not violated.



The actual results of implementating a professional employee recruiting system are rather inferior to those which were expected, but a good momentum has been developed, and a major step has been taken compared with the past work of rigid job title evaluation and determination. The problems which appear during the implementation of a professional employee recruiting system should be supplemented, revised, and perfected. One major item may be to separate professional technical job titles from professional technical positions to set up a "two-track system." Professional technical job titles represent the research standards, scholarly development, and technical contributions of S&T personnel in the area of science and technology. Professional technical positions represent the status and responsibility of S&T personnel in scientific research organs. Technical positions should have definite terms, while technical job titles can be held for a lifetime. Concerning the wage question, consideration can be given to the implementation of a system which combines job title wages and position subsidies.

12539/09599

## S&amp;T COMMITTEE FORMED IN STATE EDUCATION COMMISSION

40080023 Beijing RENMIN RIBAO in Chinese 10 Oct 87 p 1

[Article by reporter Bi Quanzhong [3968 0356 1813]: "State Education Commission Establishes S&T Committee, An Advanced Consulting and Advisory Organ To Guide S&T Work in Institutions of Higher Education"]

[Text] On 0 October 1987, the State Education Commission announced the establishment of the State Education Commission S&T Committee, an advanced consulting and advisory organ to guide S&T work in institutions of higher education. Li Peng [2621 7720], Song Jian [1345 0256], and other attended the founding conference on 9 October and commemorated the establishment of this advanced consulting organ.

China's institutions of higher education are the main front army in S&T research. Among the 400,000 full-time educators working in China's institutions of higher education, 200,000 are engaged concurrently in S&T research. He Dongchang [0149 2639 2490], vice chairman of the State Education Commission, pointed out during his speech at the founding conference that guiding work in institutions of higher education by the State Education Commission should depend on administrative systems and to a greater extent on professional systems. The S&T Committee established in the State Education Commission is just such a professional system which will participate in policymaking.

The State Education Commission S&T Committee has 57 founding members recruited from institutions of higher education throughout China. They will serve 3-year terms and consecutive terms are permitted. The famous mechanics expert, Qinghua University Professor Zhang Wei [1728 4850], is chairman of the S&T Committee. The famous chemist, Beijing University Professor Tang Youqi [0781 2589 4388], is vice chairman. Qin Guanlin [4440 7070 2651], director of the State Education Commission S&T Department, will serve as secretary.

It was decided through committee discussions that the tasks of the State Education Commission S&T Committee are: to do research and offer suggestions on important matters concerning adherence to decisions by central authorities on reforms in S&T and educational systems and related policies being drafted in the area of S&T work in institutions of higher education;

to study Chinese and foreign S&T as well as economic and social development orientations and strategies for development of S&T work in China's institutions of higher education, and to offer suggestions and reports; to offer consulting suggestions for medium- and long-term plans as well as important measures for development of S&T in institutions of higher education; to act on behalf of the State Education Commission and participate in activities related to the formulation of principles, policies, plans, and important measures for S&T development in China; to promote cooperation among schools concerning important state S&T tasks assigned to institutions of higher education, to promote integration of institutions of higher education with other departments, and to promote academic cooperation and exchange between China and foreign countries; and to do research and offer suggestions concerning strategic questions encountered during the training of Chinese S&T personnel and cooperation among S&T staffs in institutions of higher education, and to discover, encourage, and recommend talented middle-aged and young S&T personnel.

12539/9738

## ISSUES AFFECTING FURTHER REFORM OF S&amp;T SYSTEM

40080056a Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENCE OF SCIENCE AND MANAGEMENT OF S&T] in Chinese Dec 87 pp 7-8

[Article by Zhu Chuanbo [2612 0278 2672] of the General Office of the State Science and Technology Commission; editor in charge is Xu Jing [6079 7234]]

[Text] The reform of the S&T system is a tremendous engineering project. Various types of conflicts will emerge during the course. In a way, these conflicts show that our society is making progress. The resolution of these conflicts, however, is directly related to the effectiveness of the reform and to the progress of the process. There is no doubt that we must first recognize a conflict before we can solve it. In that case, what are the major conflicts in the reform of the S&T system in China? I believe the following issues must be further investigated.

#### 1. Contradiction Between the Popular Desire to Reform and Deep Rooted Tradition

Many people not only believe that reform is necessary, but also that it must be accelerated. However, when specific policies and measures are introduced, many of them often don't want to go along with them because they contradict the traditional way of thinking. Some people even resent these measures. Hence, compared to the implementation of the actual reform, it is often far more difficult to convince people to change the way they have been thinking for decades.

There are several obstacles to overcome to further the reform of the S&T system. They include: (1) Rigid understanding of the nature of socialism. Public ownership and distribution according to work are characteristics of the socialist economy. Within the connotation of public ownership, there are many issues. How to motivate all segments of society to start up S&T ventures is still a problem to be resolved. For instance, although private S&T organizations have made some progress, they are still not recognized by society.

(2) There is misunderstanding regarding commodity economy. It is not a socio-economic form to be accepted or rejected by a specific social system. Some people see a market economy as being equivalent to capitalism and being incompatible with socialism. They fail to understand that the reform of the S&T system is to resolve the issue of how to adapt S&T activities to promote the growth of the commodity economy. (3) There is a lack of understanding that

progress in S&T will push society forward. Some comrades fail to recognize that making progress in S&T is the key to promoting economic growth. They do not understand that S&T has a profound impact on every aspect of life (economy, politics, culture). (4) Feudal traditionalism is in the way. Consciousness of natural economy, lack of democratic concept in politics, exclusiveness and superstition in culture background, isolationism and self-perfectionism in S&T, and rule by people instead of law within a legal system are obstacles to the further reform of the S&T system.

It was proven in practice that to further proceed with the reform of the S&T system we must open people's minds. New concepts must be firmly planted to stay with the course of reform.

## 2. Properly Handling the Relation Between "Gearing Toward" and "Dependence"

A series of corrective measures was taken to reform the S&T system. These measures have some positive effect on gearing S&T effort toward building the economy. However, as we get further along the path, we begin to realize that reform cannot progress by stressing "gearing toward" alone to accelerate the pace and not stressing "dependence."

The harsh fact facing the reform of the S&T system is that society does not have an urgent need for science and technology. Technical advancement is not the top priority in the strategy. Technology is not treasured. Society has little respect for knowledge and talent. The industrial structure is just being adjusted. In summary, the situation where economic growth depends on S&T has not yet come about. Therefore, the depth and breadth of S&T activities geared toward the economy are limited. The rate at which operating expenses in S&T are reduced depends on the creation of a market for technology. The market, however, is determined by the demand for technical advancement from medium and large industries. To this end, the emphasis of all management levels must be shifted from minding routine operations to focussing on planning and policy making; from managing research institutions to running S&T activities for industrial and rural business; from arranging technical programs to the transfer of technical accomplishments.

## 3. Contradiction Between Vertical and Lateral Dependence for a Research Institute

Vertical dependence is a research institute's dependence on its administration and lateral dependence is its reliance on the market.

The reform weakened the vertical dependence on the original administrative office. The number of assigned projects is decreasing, while the number of tasks entrusted by society is rising. As for the source of funding, it has changed from depending primarily on the administration to relying on society. In order to secure funding, research institutions are actively pushing for technical accomplishments to satisfy the market. This change illustrates that the role of the market is expanding. The effectiveness of the old S&T system is gradually shrinking.

However, the constraint on vertical dependence and the strengthening of lateral dependence is limited. The contradiction is that when we are ready to transfer research institutions to industries and cities, the relation between them and their administrative departments is getting closer. First, the operating expenses and technical subsidies are distributed by the administration. The administration still controls investment in basic construction. In addition, the original system still has great influence over personnel assignments and revenue reduction. It is very difficult to break off this long term vertical dependence by taking short term reform measures.

Under the circumstances, the quality of research institutions cannot be rapidly improved. It will not be possible to establish the new management concept based on market demand, efficiency, profitability and competition.

To change a research institution into an independent research entity, we must change from direct management to indirect control by providing guidance and coordination. We must create conditions for the research institution to serve society in order to improve the quality of the institution through lateral dependence.

#### 4. Coordination Between Adjustment of Organization Structure and Improvement of Operating Mechanism

The recent reform is focussed on the adjustment of the operating mechanism. However, since the organizational structure of the S&T system remains untouched, the situation that scientific research and production are out of sync has not been changed. A rigid, enclosed, divided and antagonistic system still exists. Collaboration among research, design, education and production departments is mostly loose and incidental. As thousands of small businesses and millions of towns and villages are eager to tap into science and technology, some institutions are holding a considerable number of key technical talents and cannot take full advantage of their capabilities. The deployment of our technical strength has not changed. Research institutions are still affiliated with various government departments. The reform already in place has little effect on them. Research projects, funding sources and capital investment are still determined by the government. There is no relation with the economy. In addition, we do not have a policy to preferentially encourage collaboration between research institutions and industry. Only a few research institutions are involved with industry to date.

In order to rectify the situation that research and production are out of sync, the State Council issued the "Regulations Concerning Further Reform of the S&T System" in early 1987 and gave direction to reorganize the S&T system. First, we have to make a transfer to a lower level. Research organizations will be gradually transferred to industries and centers. Then, we must get involved. Most research organizations involved in the development of technology, particularly in product development, must be closely tied with industry. This may take many forms, such as a technology development center for a trade, a development center for small local businesses, a contracting firm responsible for the entire package, or a research and development type of business.



As we get further into the reform of the economic system and the S&T system, especially as the role of the market becomes stronger, the reorganization of our research institutions is unavoidable. As we continue to perfect the operating mechanism, the focus of further reform should be placed on reorganizing the S&T structure to combine research with business. Only by so doing can reform of the S&T system continue, various measures become effective, and the goals be achieved.

#### 5. Correct Handling of the Relation Between Functional Improvement and Long Term Goals

The long term goal of the reform of the S&T system is to encourage the integration of technology and economy to promote the growth of the economy and the advancement of technology. In order to achieve this goal, we have formulated a number of policies and measures. It has been proven in practice that these policies and measures are in general correct and effective. However, there are areas to be further investigated in order to properly handle the relation between functional improvement and the long term goal. In the initial stage, the reform must be centered around the long term goal. We must never deviate from this goal for functional improvement. We must never allow any conflict between these two issues. The reform will never be successful if we do not implement some fundamental changes in the old system and wish to achieve the same goal by making functional improvements alone. In addition, the impact of every policy and measure on the long term goal must be considered. Counter-measures against any negative impact must be prepared. In order to make research institutions economically independent, some of them will perfect themselves. To implement a system in which the director is ultimately responsible for everything, we have to introduce a management system to prevent an individual from making arbitrary decisions to protect the employees. This will require the tracking of every reform policy and measure implemented in order to come up with corrective measures when problems surface. Or, it may require second or multiple policy making steps, i.e., tracking policy making, to correct the undesirable portion in the original plan in order to achieve a final goal.

12553/9274



## QIAN XUESEN OUTLINES GOALS FOR CHINA S&amp;T ASSOCIATION

Beijing XINHUA Domestic Service in Chinese 1157 GMT 5 Feb 88

[By reporter Zhuo Peirong]

[Text] Beijing, 5 Feb (XINHUA)--In a work report delivered today at the third plenary meeting of the Third National Committee of the China Science and Technology Association, Qian Xuesen, chairman of the association, stressed that in the initial stage of socialism, the association's basic task should be centered on economic construction and aimed at promoting the advance of science and technology; this should be its most important goal. It should help link science and technology with economic and social development and serve the purpose of revitalizing the national economy, he said.

To promote the advance of science and technology, Qian Xuesen set forth four main tasks for the China Science and Technology Association:

First, continued efforts should be made to invigorate the activities of the association's academic societies. It is necessary to give full play to the association's multidisciplinary and multifield characteristics, further implement the principle of "Letting a hundred schools of thought contend," and encourage creative ideas. All-out support should be given to those young and middle-aged scientists and technicians who are innovative and talented in giving academic lectures. Favorable conditions should be created for outstanding personnel to come to the fore. Efforts should be made to strengthen interdisciplinary ties and to conduct comprehensive and advanced academic activities connected with major projects in economic, scientific, technological, and social development. Academic exchange, domestic and international alike, should be carried out on a wider scale. Local academic societies should conduct academic activities and develop campaigns to spread the knowledge of science in connection with the major tasks in local economic development and technological know-how urgently needed in production. They should accelerate the translation of science and technology into productive forces and should increase their vigor and vitality as academic societies.

The second task is to step up the work with regard to engineering and technical personnel of industrial and mining enterprises so as to bring into fuller play their role in promoting the technological upgrading and advance of their enterprises. On the one hand, emulation campaigns for high quality and efficiency should continue to be developed within enterprises. On the other hand, industrial and mining enterprises should offer extensive technological services and consultations so as to give full play to their role in benefiting others with their technological know-how.

Third, the work of spreading scientific and technological knowledge in rural areas should be further improved on the basis of developing the rural commodity economy. For quite a long period from now on, great efforts should be made to establish a network for spreading scientific knowledge with attention centered on consolidating and developing specialized peasant technological research institutes. Village and town popular science associations should also be invigorated. Earnest efforts should be made to run scientific and technological service organizations in rural areas and to popularize various specialized technologies according to local requirements. At the same time, it is necessary to promote cooperation between higher education institutions and agrosience research organizations on the one hand and the specialized peasant technological research associations on the other and to provide a technological support for the popularization of scientific knowledge in rural areas.

Last, science associations in higher education institutions should extend their work to the students. They should promote the exchange of and dialogue on new knowledge and improve the school curricula. Students of physical science, engineering, medicine, and agriculture should learn something about liberal arts, while students of liberal arts should take in some knowledge of modern science. At the learning stage, students should be given more opportunities to attend various academic activities so as to expand the scope of their knowledge.

The above, Qian Xuesen pointed out, are the main tasks of the China Science and Technology Association in the new period and that all work of the association's organizations should be closely linked with them.

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CSO: 40080065

## METEOROLOGICAL ADMINISTRATION ESTABLISHES CHINESE-LANGUAGE TELECOMMUNICATIONS NETWORK

40080075 Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 20 Jan 88 p 1

[Summary] China's Meteorological Administration, after 2 years of research and development centered on the Beijing Weather Center communications hub's mainframe computer system (the "BQS System"), has set up a Chinese-language computer telecommunications network which organically unites the Administration's Main-Office-based local area network (LAN) via the BQS System with various provincial authorities' computer systems. By the end of October 1987, routes from all provinces (except Xizang [Tibet]) to Beijing had been established. Results from the trial run are quite good, which will greatly speed up information exchange and improve office efficiency. The system will be formally put into service in 1988.

The system consists of three parts: the Administration's LAN, the BQS System, and the provincial authorities' computer systems. The aforementioned LAN is a link-up of horizontally aligned administrative offices with the Main Administrative Office so that the officials can keep up with events via data exchange and sharing of resources, and utilizes the OMNINT network; it currently has 12 work stations, each with a Great Wall 0520-series microcomputer. The BQS System, which is beginning to have a major effect on all Chinese-language telecommunications systems, can transmit documents from the Main Office to the provincial authorities. Data reports from the provincial offices also go through the BQS System at a baud rate of 75 to the various offices of the Administration's LAN.

The Administration's system consists of telecommunications software and an adapter. The provincial offices, via an RS-232 interface, a low-cost adapter, and telecommunications software, use the BQS System to transfer documents in odd free moments between transmissions of teletype weather reports. The telecommunications software, via a dedicated line, transmits the Chinese-language documents converted into CCITT five-unit code.

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SATELLITE AGREEMENT WITH NORWAY

40080072c Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 27 Jan 88  
p 2

[Text] Beijing, 27 Jan--The Ministry of Communications recently signed a US\$8-million-plus agreement with Norway to purchase a maritime satellite ground station system.

This station will use multiprocessor instrumentation to control telephone, telegraph, and teletype transmissions. In the space of a few seconds, the user can clearly hear the other party's voice while simultaneously transmitting data at 4,800 bps.

Installation of the station is projected to be completed by early 1989, with operation beginning in the first half of that year.

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NETWORK TO PROMOTE TRANSFER OF TECHNOLOGY

Bijing CHINA DAILY in English 10 Feb 88 p 1

[By staff reporter Nie Lisheng]

[Text] A national network of technical markets has emerged around the country to facilitate the transfer of technological advances from scientific research institutions to enterprises.

The country now has more than 5,000 state-run technical trade organizations and nearly 10,000 non-government ones to help scientific research institutions sell their technical know-how and inventions.

Last year, the total technical trade volume jumped to a value of over 3.3 billion yuan, compared with 2 billion yuan in 1985 and 700 million yuan in 1984, when the state began to reform its rigid scientific research system.

Under the old system, scientific research organizations were supported almost entirely by state funds, and their technical products were free for use by all enterprises.

Research institutions made no profits from the sale of their research results, and under the country's existing economic system before reforms were introduced, enterprises had little motivation to increase their profits. As a result, neither party made much effort to adopt new technology to production as soon as possible.

Technical markets have gained much ground in the past year and should be further expanded to handle a total transaction turnover of 5 billion yuan this year or next year, said Song Jia minister of the State Scientific and Technological Commission.

He said the ultimate success of China's economic and scientific research reforms depends greatly on a well-developed technical market system.

Technical improvement has been hampered at many enterprises by the lack of information about new technology, new scientific inventions and new products, he said. Also, many scientific research institutions developed new technology and highly-efficient techniques but could not find the right channels to sell their research results to enterprises.

According to the National Centre for Management and Promotion of Technical Markets, such markets have helped scientific research institutions raise funds themselves instead of depending solely on state allocations.

There have been four major types of technical markets in China. In Beijing, Tianjin, Wuhan, Shijiazhuang and Chengdu, regular markets have been set up at permanent sites, where dealers and customers can meet whenever they wish.

Another type is called the mobile market, where research institutions send employees directly to enterprises to sell their technical products.

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## ADVANCES IN SUPERCONDUCTOR RESEARCH: REPORTED

BaO-Y<sub>2</sub>O<sub>3</sub>(La<sub>2</sub>O<sub>3</sub>)-CuO Phase Diagram

40080027 Beijing KEXUE TONGBAO [SCIENCE BULLETIN] in Chinese No 17, 1987  
p 1360

[Article by Che Guangcan [6508 1639 3503], Liang Jingkui [2733 2417 7608], Chen Wei [7115 4850], Jie Sishen [6043 1835 3234], Yu Yude [0205 5148 1795], Li Hua [2621 5478], Yang Qiansheng [2799 0051 5116], Ni Yongming [0242 0737 2494], Liu Guirong [0491 2710 1837], and Chen Genghua [7115 6342 5478] of the Chinese Academy of Sciences Physics Institute, Beijing: "Research on BaO-Y<sub>2</sub>O<sub>3</sub>(La<sub>2</sub>O<sub>3</sub>)-CuO Ternary Phase Diagrams"]

[Text] We studied the phase relationships of BaO-Y<sub>2</sub>O<sub>3</sub>-CuO systems, and we made a room temperature cross-section diagram of a CuO-rich region (CuO > 50 mol percent) and measured the crystalline structure and superconductivity of compounds with CuO-rich regions in this ternary system. Two compounds were discovered within this region: Ba<sub>2</sub>YCu<sub>3</sub>O<sub>9-x</sub> and Y<sub>2</sub>BaCuO<sub>5</sub>. Ba<sub>2</sub>YCu<sub>3</sub>O<sub>9-x</sub> has an orthorhombic distorted perovskite structure, with  $a = 3.892 \text{ \AA}$ ,  $b = 3.824 \text{ \AA}$ ,  $c = 11.64 \text{ \AA}$ , and space bunching of Pmmm. This compound is a high T<sub>c</sub> superconducting phase and has a zero-resistance temperature of 92 K. Because the Ba<sub>2</sub>YCu<sub>3</sub>O<sub>9-x</sub> exists over a very wide region, it is quite easy to obtain superconducting samples of various mixtures within the Ba-Y-Cu-O system. The phase within the samples with superconducting properties was the Ba<sub>2</sub>YCu<sub>3</sub>O<sub>9-x</sub> phase. Y<sub>2</sub>BaCuO<sub>5</sub> belongs to an orthorhombic crystal system and has cell dimensions  $a = 7.123 \text{ \AA}$ ,  $b = 12.163 \text{ \AA}$ , and  $c = 5.649 \text{ \AA}$ . We were unable to obtain a single-phase superconducting sample of this compound, so the superconductivity of this compound was not confirmed. According to the phase diagram, we studied the relationship between constituents and superconductivity. The temperature of thermal processing of the samples also had major effects on superconductivity. Different thermal processing procedures would provide insulators, semiconductors, and metallic superconductors. In addition, the results of X-ray diffraction also indicated variations in the shape of the diffraction peaks of different thermal processing samples. This result also may correspond to the quality of superconductivity. We can conclude from the results of our experiments that crystalline structure has substantial effects on superconductivity, and there is a very strong relationship to the oxygen content of the structure.



The cross-sectional room temperature phase diagram of a CuO-rich region in a BaO-La<sub>2</sub>O<sub>3</sub>-CuO ternary system has been completed. Within this range, there are several compounds, LaBaCu<sub>2</sub>O<sub>5+δ</sub> (or LaBa<sub>2</sub>Cu<sub>3</sub>O<sub>8-x</sub>), La<sub>2-x</sub>Ba<sub>x</sub>CuO<sub>4</sub> (0 < x ≤ 0.07), LaBa<sub>4</sub>Cu<sub>5</sub>O<sub>14+δ</sub> and BaLa<sub>2</sub>Cu<sub>2</sub>O<sub>6</sub>. Of these, LaBaCu<sub>2</sub>O<sub>5+δ</sub> (or Ba<sub>2</sub>LaCu<sub>3</sub>O<sub>9-x</sub>) and La<sub>2-x</sub>Ba<sub>x</sub>CuO<sub>4</sub> (0 < x < 0.07) also are distorted perovskite-type compounds, and they are confirmed superconductors.

#### Electrical Fields in YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7</sub> Superconductors

40080027 Shanghai ZIRAN ZAZHI [NATURE JOURNAL] in Chinese Nov 87 p 557

[Article by Wen Shulin [3306 2885 2651], Song Xiangyun [1345 4382 0061], Feng Jingwei [7458 2529 0251], Lu Lisheng [7627 7812 3932], and Li Cheng'en [2621 2110 1869] of the Shanghai Silicate Institute, Chinese Academy of Sciences: "Research on Electrical Fields in YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7</sub> Superconductors"]

[Text] We carried out electron diffraction studies and high-resolution electron microscope examinations of YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7</sub> superconductors, which have a zero-resistance transition temperature of 95 K.

The research showed that the grains of this material were ceramic polycrystalline bodies a few microns in size. The results of electron diffraction indicated that the orientation of these grains is completely random. However, an interesting phenomenon exists in these grains: an electrical field often is seen when observing the [001] orientation (as shown in Figure 1) [not reproduced]. The existence of an electric field implies that spontaneous polarization and polarons created by the spontaneous polarization exist within the cells. According to the Jahn-Teller Effect, this could create a very strong interplay of electrons-phonons<sup>[1]</sup>, an indispensable aspect of superconducting oxides.

High resolution electron microscope observations were made of the material sample in the [100] direction. We discovered traces of Cu<sup>2+</sup> and O<sup>2-</sup>. Figure 2(a) is a structural image of the superconductor in the [100] direction. Figure 2(b) is a computer-generated image of this direction (used to indicate a projected image indicating the Y, Ba, Cu, O, and other atoms in this direction). The difference between the atomic sites in Figure 2(a) and Figure 2(b) indicates the existence of spontaneous polarization within the cells. Analysis and computations indicate that the constituents of this superconductor should be expressed as YBa<sub>2</sub>Cu<sub>2</sub><sup>II</sup>Cu<sub>1</sub><sup>III</sup>O<sub>7</sub>, while the spatial position of the oxygen is between the Cu<sup>II</sup> and Cu<sup>III</sup> ions.

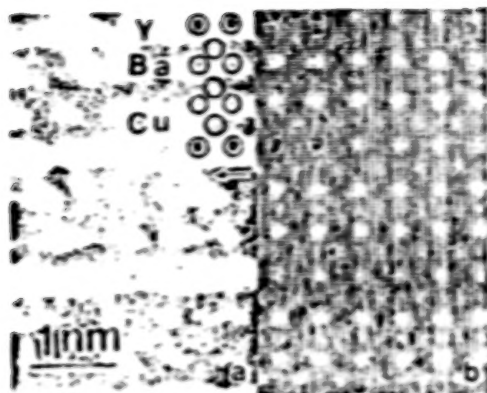


Figure 2. (a)  $\text{YBa}_2\text{Cu}_3\text{O}_7$  [100] direction structural image  
(b) Theoretical computer-generated image in the same direction

#### REFERENCE

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#### Superconducting Oxide Monocrystal

40080027 Beijing RENMIN RIBAO (Overseas Edition) in Chinese 26 Nov 87 p 4

[Article: "China Makes World's Largest Superconducting Oxide Monocrystal--Transition to Superconductivity Begins at Absolute Temperature of 95 K, Something of Major Importance for Understanding Basic Characteristics of Superconductors"]

[Text] The Joint Superconducting Materials Research Group at the China University of Science and Technology has prepared barium-yttrium-copper-oxygen superconducting compound monocrystals, which included a monocrystal 3 mm long, 2.5 mm wide, and 1 mm high, making it the world's largest superconducting oxide monocrystal.

This large volume monocrystal was grown by the research group using a flux method. It was confirmed recently after testing and analysis by the University of Science and Technology Structure Center that this monocrystal is an orthorhombic crystal system. The results of alternating current magnetization rates and resistance measurements made by the Low Temperature Physics Laboratory showed that this monocrystal was highly antimagnetic and that the transition to superconductivity begins at an absolute temperature of 95 K. The temperature of zero resistance is 89.5 K, and the transition width is less than 1.2 K. All of these indices attained advanced international levels.

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